ENGINEERING

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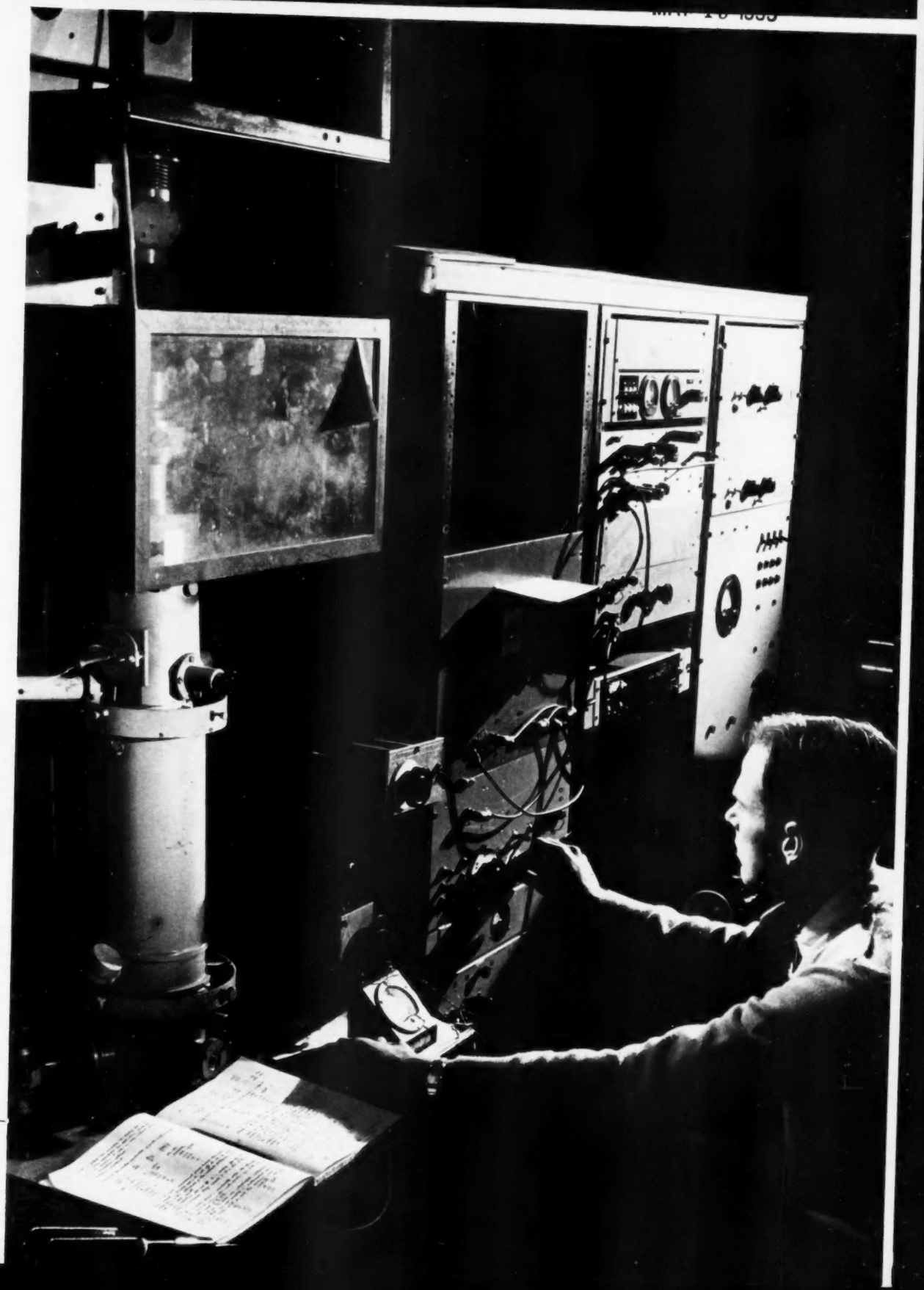

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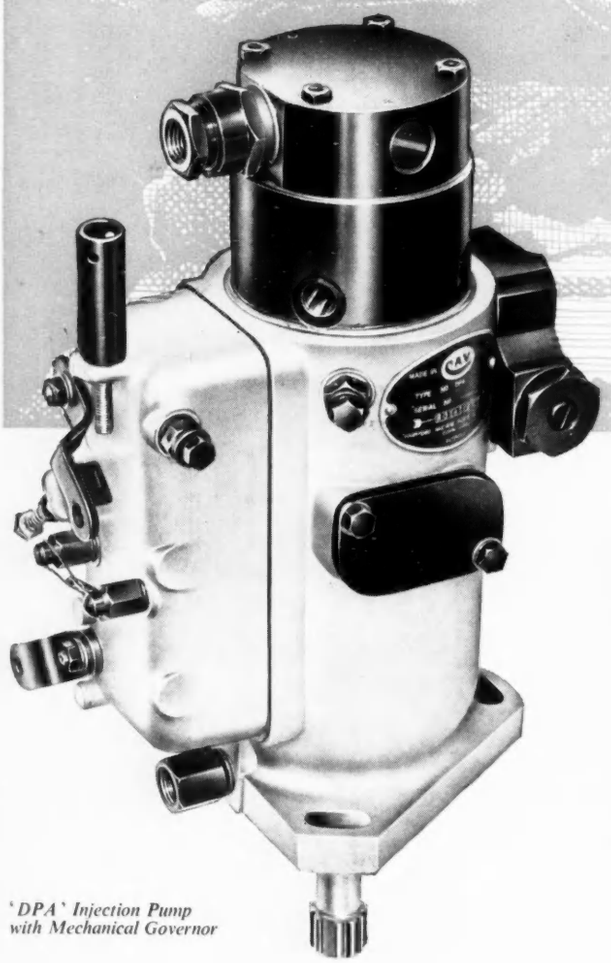

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ENGINEERING

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ENGINEERING *Appointments Section faces page 554*

Like Children

AN engineer whom we asked to examine a report for us and give his opinion, remarked: "While recognising the service that mathematics can render to engineering, and admitting that the algebraic form of expression is often a useful word-saver, I think that in this paper it has been brought in rather unnecessarily, to the detriment of clear exposition."

Mathematics are like children—your own can be great fun, but other people's can be desperately boring, even embarrassing. If this seems at variance with the idea of mathematics as the universal language of science, then the fault lies with those of us—the majority—who fail to make the best use of mathematics. Over the past decade there has been a spectacular increase in the use of mathematics by industry, not only in pure research but in production and distribution as well. The use made of mathematicians by E. I. du Pont de Nemours and Company is described in the current issue of their house journal. The ancient science of mathematics, the article says, has become "a field of new and profound importance to the public in general and to du Pont employees in particular."

Scientists and engineers have always used mathematics in their work. It has been a basic and most useful tool but it is only in recent years that the mathematician has become an integral part of the scientific group. Du Pont describe mathematics as "in many respects a new and uncharted field of study." Some of the theories now in constant use were not even formulated five years ago.

A great deal has been written about the contributions which operational research, a mathematical approach to organisational problems in industry, is making to productivity. Even more on the subject of computers and their wizardry. Too little, however, is known about the mathematician's functions in industry. The reason for this lack of knowledge is probably the public feeling, which is accurate enough, that the mathematician deals in the most abstract of concepts. It is probably true also that the men who live and work "in the wondrous world of the abstract" are poor at public relations. They find it easier to communicate with symbols than with words and this may be the root cause of the neglect of the teaching of mathematics in British schools, as we discuss later.

The American company are specific on the mathematician's achievements in the field of product development: "they have made mathematical 'models' many times, with the result that several plants are today operating with an efficiency never achieved before. . . . Using different techniques they have helped design new machines that can be built for less money, rescheduled production and maintenance work, and broken some major roadblocks in research." The company give concrete examples of the work and achievements of their mathematicians. At one plant mathematicians were able to save several hundreds of thousands of dollars by simplifying nitric acid oxidation equipment; at another, laboratory data that once represented weeks of work is collected in two hours; and at a third mathematical analysis cut the number of steps in routine testing procedures and saved $50,000 a year.

It is against this background of highly constructive interventions by the mathematicians in research, manufacturing and distribution that the recently published report of the City of Manchester Education Committee makes such sad and disturbing reading. Entitled *The Teaching of Mathematics in Manchester Secondary Modern Schools*, the report was prepared by the committee's inspectors of schools. They conclude that traditional ways of teaching mathematics are outdated and need to be replaced. The roots of the trouble lie in primary schools. Comparison of the arithmetic quotients with the intelligence quotients of pupils on entry to the more modern schools at 11 years of age indicated that the pupils with the higher intelligence quotients had not reached the full extent of their potential in mathematics in primary schools. They came to the secondary schools with inadequate knowledge of weight and measure and with inadequate understanding of spatial relationship. The shortage of suitable teachers was the greatest obstacle towards a change for the better. Out of a total of 607 teachers in the 37 secondary modern schools investigated, only 8 had a degree which included mathematics and 3 of these were on the staff of one large school; but some 300 actually taught mathematics.

The inspectors concluded in their report that the scope of mathematics teaching should be widened beyond the "language" of numbers to include measurements, comparison, size, shape, direction and mathematical relationships generally. Children, it is suggested, are at present denied excitements inherent in mathematical ideas which permeate modern everyday thinking and also the satisfaction derived from applying them with success in real-life situations.

Cover Picture.—*For many purposes the scanning electron microscope developed in the Cambridge University Engineering Laboratory has important advantages over more conventional types. It is particularly useful for objects which cannot be prepared in the form of thin sections when replication is inconvenient or impossible.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

At exhibition time superlatives become a commonplace. From all quarters we hear dramatic claims that this is the largest, the smallest, the fastest, the straightest, the highest, the longest, the shortest, or the tallest of its kind in the world. I am beginning to find it all rather tiresome, and tend to yawn at each fresh announcement of a new something with the mostest. Is it assumed that our receptivity is so jaded that we can only appreciate the simplest kind of uniqueness? Or is the adman's imagination so dulled that he can discover no other key to our attention? Maybe it's the way we are brought up—in a world where confidence depends on prestige, and prestige depends upon our placing in some tacit universal contest. The habit is so ingrained that whenever someone tells me that Los Angeles or Tokyo is bigger than London, I find myself arising indignantly to London's defence. That is why I found Finland so refreshing. There it doesn't seem to matter.

I have always been fond of Finland. When I was twenty-two I spent a few months working there under an exchange scheme, and besides learning that engineering is a language without frontiers, I made the acquaintance of a country that has the subtle quality of being just right. Neither diffident nor demonstrative, Finland combines vigour and civilisation in an unusually happy combination. But there is one recollection that seems to me to characterise the Finns. I remember on perhaps half a dozen occasions being strongly advised to visit Naantali. Naantali, they told me, was the second smallest city in Finland. I never discovered which city was the smallest, and no-one seemed to know.

I never went to Naantali, but I found the recommendation "second smallest" so endearing that I sold my return ticket in order to stay a little longer in a country whose people could cherish so delicate a distinction.

I am sure the engineers in the locomotive factory where I worked in Tampere never set out to make the largest or the fastest locomotive in the world; they simply designed it for the job. Come to think of it, what engineer would do otherwise? To make the biggest is in a way to fall short: you would make it even bigger if you could. Whereas to make it, like the baby bear's porridge, just right is to achieve your purpose. I suppose it's only afterwards that someone comes along and finds a suitable superlative.

Even the Finns slip occasionally. Whereas in almost every European language, from Russian to Spanish, the words for "electricity" are recognisably similar, in Finnish it is "sähkö," named, I understand, after the Finnish gentleman who first invented it.

CAPRICORN

Weekly Survey

Folly of Subsidising Power

Addressing the Economic and Social Council of the United Nations Organisation in Mexico City, the President of the International Bank for Reconstruction and Development spoke bluntly of the folly of subsidising public utilities in underdeveloped areas. Mr. Eugene Black was drawing attention to the need to develop domestic savings in such areas since foreign capital could never be the whole of the answer to the need for a high level of capital investment.

Underdeveloped countries must face a basic question, he said: "Do you want subsidised power or do you want more schools? Do you want a free ride on the railroad or a city sewer system?" The only way to get the better social services was by making utilities charge high enough prices at the very least to reserve sufficient profits to replace their own assets. In particular, it was necessary to remove the fallacy that poor countries need pre-eminently cheap-power. Except for aluminium, this was not often so. What such countries needed was a large supply of power. He quoted figures for Mexico as an illustration, showing that the cost of electric power averaged only 1·7 per cent of total costs of production. It could not be argued that with such statistics marginal differences in the price of power encouraged or discouraged the establishment of new industries.

He quoted two cases, among others, where higher charges by public utilities had proved the right policy. The first was the Indian railways under the second five-year plan. Good financial management had brought a substantial surplus and a similar policy was to be used in the power utilities. Surpluses over what was necessary for depreciation and new investment could go to finance the second five-year plan. In Central Africa, the Kariba Gorge project was originally planned to provide subsidised power. After a survey among potential users carried out at its own expense, the Bank persuaded the Federation Government to raise tariffs by 35 per cent, using the resulting surplus to finance later stages of the Kariba scheme.

The important stroke of judgment, of course, is to decide how far it is sound to raise prices to make a utility pay its way and how far to go further and use is as a financial milch cow. In backward area where local savings from income are small there is a good case for boldness in the matter.

Royal Naval Research

Research undertaken by the Royal Navy is expected to cost rather more than £14½ million in the coming year. Much of the work, which covers such subjects as development of propulsion machinery, experiments with anti-fouling paints, and the development of escape apparatus from aircraft and submarines, is in the hands of the Royal Naval Scientific Service, which has succeeded the Admiralty Board of Invention and Research. The Navy thus differs from the other two armed services in being responsible for a large part of its own scientific research, while the Army and the Royal Air Force rely in the main on the Ministry of Supply.

One hundred years ago, I. K. Brunel, who was impelled by the inefficiencies of the Crimea campaign to evolve ideas for siege artillery mounted on semi-submerged hulls, and had many other contracts with the Admiralty in the course of his work on shipbuilding and railway construction, expressed the opinion that to submit an invention to the Admiralty was the surest way to bury it for ever. Recent developments by the RNSS, however, such as the Tactical Teacher by which naval officers can plan actions in the classroom, have been considerably in advance of developments in other countries and have been adopted by the USA, Canada, and other NATO nations.

A recent development was the inauguration at Portland of the Underwater Weapons Establishment, which will eventually merge the work of the Torpedo Experimental Establishment, Greenock; the Torpedo Depot, Weymouth; the Underwater Counter Measures and Weapons Establishment, Havant; and the Underwater Launching Establishment, West Howe.

Factory Plans Approved

The industrial recovery is still young and undeveloped enough to be killed off by untimely frosts this spring. The Budget has been designed to obviate this as soon as possible by stimulating purchasing power and encouraging capital investment. Nevertheless, any signs of recovery, especially on the side of capital investment, are to be received with relief.

Some indication of better things to come can be derived from the latest quarterly figures of Industrial Development Certificates given for new factory space. In the first quarter of 1959, the total area approved was 15·8 million sq. ft, compared with 11·2 million sq. ft in the fourth quarter of 1958, and with 11·8 million sq. ft in the first quarter of 1958. Owing to a large scheme receiving approval in Wales in the first quarter of the year, the number of schemes approved showed a rather less spectacular increase than their area. However, at 535 schemes approved for the quarter, it was the best return since the first quarter of 1958.

In recent years, the trend of factory plans approved has provided a very good indication of the trend of the trade cycle in the period six to nine months ahead. There is reason, therefore, to expect that it will also apply on this occasion. If the better figures for the first quarter are confirmed by those for the second quarter, the likelihood of a marked recovery in the capital equipment industries will be very strong indeed. At present, capital investment, and consequentially, the prosperity of the engineering industry, is being sustained by business placed by the public corporations, by local government, and by non-manufacturing industry such as the retail trade. Private manufacturing industry may soon start to increase investment, helped by the Budget, and higher levels of factory plans to be approved should follow.

Shipowners Suspect

In a paper with the title "Some Shipowners' Problems" read before the North East Coast Institution of Engineers and Shipbuilders, Mr. R. Munton referred to the difficulties created for shipowners in the ordering of new ships by the increased employment of specialist subcontractors in the shipbuilding industry. He pointed out that the functions of the shipowners' technical department are broadly: maintenance of existing vessels, to ensure that such vessels are operated at maximum efficiency; to coordinate the owners' requirements as regards new vessels and present these to the builders; and to endeavour in conjunction with the builder to produce improved designs, increased efficiency, and reduce maintenance costs.

On the subject of new ship design and construction, two main problems occur: the case of a new vessel similar in type to an existing vessel of which the owner has knowledge and experience;

and the case of a different class of vessel where the owner's technical department may not have the experience to provide a complete specification. In the latter case, the builder is frequently asked to provide a guidance specification, a system which worked well as long as the shipbuilder constructed practically everything required for the ship in his own yard. Owing, however, to increased employment of specialist subcontractors, the author claims that builders tend to lose their know-how. There is an inevitable tendency in such cases for the shipbuilder to rely on a particular subcontractor who has provided satisfactory service in the past, but in a number of cases this practice results in the subcontractor taking advantage of the position in the price charged. If alternative quotations are to be obtained for the subcontractors, very comprehensive specifications are required.

Pattern for Pakistan

Two reports have been published recently on economic planning in Pakistan. The first of these is a PEP broadsheet called *Planning in Pakistan* (price 2*s* 6*d*) and the other is *The Prospect for Nuclear Power in Pakistan*, put out by the National Planning Association in Washington.

The PEP report points out that Pakistan is one of the poorest countries in the world and that partition was an immediate obstacle to economic progress when it occurred. It caused severe disruption of long-established patterns of trade and transport and no administrative system or cadre existed to carry out any economic reconstruction. After a chequered start, economic planning was put on a more orderly basis in 1953 by the creation of the Pakistan Planning Board, which brought out a five-year plan in the following year. The PEP broadsheet considers that "the results of economic planning in Pakistan during the past decade can be summarised as brilliant, uneven and inadequate." The five-year plan gave first place to improving agriculture and this is not considered to have been a particularly happy priority. The broadsheet discusses future planning, which together with the techniques of planning, is likely to improve more than the real resources on which any plan must be built. The authors of the broadsheet are worried about political instability and the high rate of increase of population.

A similar overall account of Pakistan's economic development in the last decade is set out at the beginning of the American brochure. Emphasis is laid on the shortage of capital and the problems created by abrupt partition. This publication goes on to deal with fuel and power costs and the prospects for nuclear energy. Conventional power costs in Pakistan are high by most standards. The completion of thermal plants now under construction or drawn up on paper along with the Karnaphuli hydroelectric installation will meet anticipated power requirements in East Pakistan up to 1965. Beyond that date, additional power will have to be thermal, either conventional or nuclear. The area around Dacca has adequate natural gas for power generation and there is hydroelectric power for the South East. Large nuclear power stations (60 MW) will probably not be constructed in East Pakistan before 1975. Small scale nuclear plant may find a use in irrigation and for village industries. The main problem in nuclear development is lack of personnel.

Distributing Largesse

The recently issued White Paper *United Kingdom Balance of Payments 1956 to 1958* (HMSO, Cmnd. 700, price 1*s* 3*d*) records a favourable balance on current account provisionally estimated for 1958 at £455 million. A very large surplus was expected, and an interesting fact disclosed by the White Paper is how this balance was used. For the first half of the year, the balance was absorbed in building up the gold reserves of the United Kingdom, and in the second half of the year, an increased amount was used as long-term capital for investment abroad. Indeed, no less than £236 million was invested overseas in one way and another by this country in 1958, thereby maintaining the high level of capital investment abroad, particularly in the sterling area, which this country has established in the last few years.

It might have been expected that the very substantial level of United Kingdom investment in the sterling area would also mark a period when such investment in the sterling area eclipsed that from other sources. That, however, was not so. A high level of United Kindom investment in the sterling area was matched by an even higher level of investment in sterling area countries by the rest of the world. Last year, the deficit on capital account between the rest of the sterling area (excluding the United Kingdom) was £368 million, compared with £257 million in 1957 and with £157 million in 1956. Dollar aid, investment by the World Bank, and operations by the International Monetary Fund have been the main causes of this buoyant level of investment.

Taken together, these sources of capital for the rest of the sterling area came to £599 million; for this country invested £231 million last year in the sterling area out of its balance of long-term capital of £236 million: an exceedingly satisfactory achievement. The result has been that, although many countries in the sterling area have suffered over the last 18 months or so from low prices for their exports, they have not been starved of long-term capital. This must mean that the recovery in those countries now that world commodity prices are rising will be accelerated by foreign investment and their ability to import machinery and equipment correspondingly improved.

Reasons for Modernising Railways

The railway modernisation schemes undertaken before the Second World War, including electrification by the Southern Railway in this country, the electrification of the Swiss Federal and Italian State Railways and of the Great Indian Peninsula Railway were undertaken either to meet the specific demands of passenger traffic or to eliminate dependence on imported coal. These reasons were given in a paper read to the Railway Students' Association at the London School of Economics and Political Science on 4 April by Major-General L. Wansbrough-Jones, C.B., C.B.E., secretary-general of the British Transport Commission, who reviewed railway modernisation schemes throughout the world.

In recent years modernisation schemes have been put in hand primarily to make good the destruction or lack of maintenance and development of railway systems during the war. After commenting upon post-war developments in Switzerland, Holland, France, Belgium, Italy, Western Germany, India, Australia, Spain, the Republic of Ireland, Japan and the United Kingdom, the author pointed out that none of these countries decided that it could do without its railways, although no doubt in some countries, as in the United Kingdom, minor improvements were proposed for the abolition of railways or for their conversion to roads. One of the principal features of virtually all modernisation plans had been the introduction of diesel or electric traction and the elimination of steam, leading to increases in train speeds and consequent improvements in the permanent way and signalling systems. The author stressed that in future these developments must increasingly have greater productivity as their aim, and that this tendency would focus attention on the need for improved organisation of the railways.

In turn, there would be required a modernisation of outlook as well as of fixed assets, involving freedom and flexibility in fixing fares and charges and a fresh commercial outlook within the railway system itself. The railway organisation would require streamlining in order to reduce the number of departments reporting directly to top management, while, at the same time, increasing the authority of the people "on the ground." Given these developments, the author believed that the railways would be assured of public sympathy and cooperation, and that mistrust on the score of the large sums of money now being spent on the modernisation of equipment would disappear.

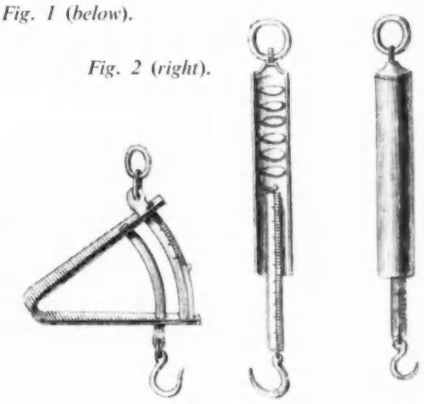
MANCUR SPRING BALANCE

SIR, I refer to Mr. J. F. Perrin's inquiry concerning the Mancur spring balance, published on page 355 of your issue of 20 March, and to the reply by Mr. L. Sanders, on page 419 of your 3 April issue. It will please Mr. Perrin to learn that we have a Mancur balance on exhibition in the weighing-and-measuring collection at the Science Museum. I do not think I am making an overstatement if I say that this collection is one of the nicest and most complete in Europe.

Although I have nothing to add to Mr. Sanders's elaborate reply, I would like to supply some additional information as to what I have discovered about this object. This C-shaped weighing device has hooks attached near each end. One hook is held stationary while a weight is suspended on the other: this tends to straighten out the "C," made of spring steel, to an extent proportionate to the weight on the second hook. The Mancur balance was preceded by Wiedeman's balance, which was nearly the same in design.

Fig. 1 (below).

Fig. 2 (right).



The earliest balance of the C type still existing is at the Hanseatic Museum, Bergen. It was made by H. Broelle in 1783. One is therefore led to believe that "Mancur" is the name of a scale-maker. This is the conclusion arrived at by W. Airy in 1905. He was a well-known authority on the subject in his day. The Mancur balance followed the V-shaped spring balance shown in the accompanying Fig. 1, taken from the *Dictionnaire des Sciences*, published by Diderot and d'Alembert in 1763.

I agree with Mr. Sanders that this type of balance was not accurate enough for measuring small weights. It was rivalled by the coil-spring balance in 1763, shown in Fig. 2, which was then in its infancy. It was later introduced for general use, and so continued over many years to come.

I am, Sir, Yours sincerely,

C. ST. C. DAVISON,
Assistant Keeper.

Science Museum,
South Kensington, London, SW7.
11 April, 1959.

MOBILE CRANE
Lifts 20 tons at 10 ft radius

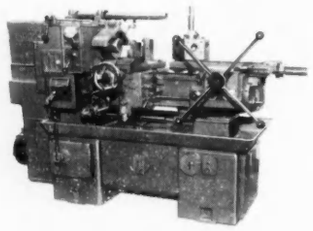
THE Jones KL12-20M mobile crane, built on its own self-propelled chassis, is the first of three, the others being lorry mounted and rail mounted versions. On standard British ratings it will lift 12 tons at 10 ft radius standing free, or 20 tons with the outriggers extended.

The chassis is mounted on four wheels with 14·00 by 24 heavy duty tyres. Two-wheel drive is standard. There is a differential with a locking arrangement. The brakes are sufficient to hold the crane on a 1 in 5 gradient. Steering is hydraulic. When fully loaded the maximum recommended travelling speed is 2 m.p.h.; unloaded, the crane will negotiate a 1 in 5 gradient.

Largely of new design, the crane incorporates the direct diesel mechanical transmission system in use in other models and also the general arrangement of the machinery. Power is supplied by a Perkins Four 270D engine which develops 62·5 b.h.p. The drive is through a Borg and Beck clutch and a four-speed gearbox. From the last the drive is by chains to the various motions.

The standard jib is 30 ft long but can be extended by the introduction of 20ft sections up to 90 ft. With a six-fall block the full load can be raised at 20 ft per minute. *George Cohen 600 Group Limited, Wood Lane, London, W12.*

CAPSTAN LATHE
Screw Cutting at the Cross Slide



A SPECIAL feature of the Murad 4D capstan lathe is the provision of a screw cutting facility at the cross slide, the chosen pitch being quickly available by use of a tumbler type quick-change gearbox. The customer is able to specify any six pitches between 8 t.p.i. and 26 t.p.i., the only restriction being that 12 t.p.i. must be included.

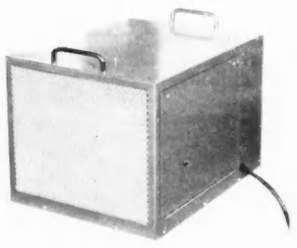
The main spindle is mounted on Timken high precision taper roller bearings under pre-load at the front bearing and on plain sliding rollers at the rear bearing. Provision is made to compensate automatically for spindle expansion with rise of temperature.

Sixteen spindle speeds are available, ranging from 50 to 1,500 r.p.m. The collet mechanism is pneumatically operated under finger tip control. A pneumatic brake operates automatically in conjunction with the speed change and reversing levers.

In addition to the screw cutting facility at the cross slide there are six rates of automatic feed available for both sliding and surfacing, reversible in both cases. Automatic disengagement of the feed is effected by pre-set stops on the indexing stop bars, both for sliding and facing cuts. A chasing dial is provided for assistance in screw cutting and the lead screw nut and feed engagement are interlocked so that neither can be engaged while the other is in operation.

The hexagon turret is 8⅛ in across flats and the height from top of turret slide to centre of tool hole is 2¼ in. The bar capacity of the machine employing collets is 2¼ in diameter and employing a chuck 2½ in diameter. *Murad Developments Limited, Stocklake, Aylesbury, Bucks.*

DEHUMIDIFIER
Refrigerating Unit for Dry Storage



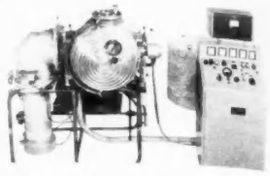
TO dry the air in a storage room, Westool have produced a refrigerating unit which weighs only 55 lb.

The unit measures 15 in by 12¼ in by 10½ in high and will handle the normal requirements of a space of 2,000 cu. ft. It has a water extraction rate up to 1 pint per hour. After drying, the air is heated and returned to the room. With an air inlet at one end and outlet at the other the unit can be stood on a shelf or incorporated in ductwork. There is provision for an air filter if one is desired. Units can also be arranged in banks for multiple installations.

The refrigerating system is hermetically sealed and filled with dichlorodifluoromethane; control is by capillary tube. The compressor is driven by a ⅛ h.p. motor. The circulating fan is of aluminium and direct coupled to a shaded pole motor. Air circulation is at the rate of 150 cu. ft per minute. The wiring is so arranged that the fan can either be run in conjunction with the compressor, or else continuously, with the compressor under humidistat control.

The unit will work continuously at ambient temperatures up to 100° F, above which the compressor cuts out on overload and the unit cycles automatically. Since the action relies on refrigeration, the performance is dependent on the ambient conditions; at 80° F relative humidities of 35 to 40 per cent are obtainable falling to 55 per cent at 55° F. With low ambient temperatures frosting may occur and the fitting of a time switch to give two or three short de-frosting periods each 24 hours is recommended. *Westool Limited, St. Helen's Auckland, Co. Durham.*

VACUUM FURNACE
General Purpose Pilot Plant



A SMALL general-purpose vacuum furnace suitable for research work or small scale pilot production is now being made under the agreement recently completed between the General Electric Company and Vacuum Industrial Applications.

The furnace is designed to enable laboratories and small workshops to cover with a single unit a wide range of vacuum heating processes, including sintering and outgassing. Easy operation is obtained by the fitting of simple vacuum, mechanical and electrical controls. Internal diameter of the work chamber is 24 in and it is clad with stainless steel to facilitate cleaning and to reduce degassing.

The furnace chamber is fitted with externally operated handling gear for making additions to a melt or for taking temperature measurements and for tilting the crucible. A window is provided at the top of the chamber for observing the progress of a melt. Internal handling mechanism can be viewed through a window set into the chamber door.

Graphite, tantalum, tungsten or molybdenum can be used for the resistance heaters according to the particular process and specified vacuum. With a refractory crucible, temperatures of 1,200 to 1,400° C can be achieved, while if a graphite crucible is used it is possible to obtain temperatures up to 1,800° C.

In the induction heating versions, a 10 kW, 10,000 c/s generator is used which will give temperatures in excess of 1,700° C in the charge for melting, and when the sintering assembly is used the power is absorbed in a graphite susceptor where temperatures in excess of 2,400° C can be achieved. A two-stage high-speed pumping system is used to evacuate the furnace tank. Vacuums of the order of 10 to 5 mm mercury can be obtained. *The General Electric Company Limited, Magnet House, Kingsway, London, WC2.*

HIGH SPEED PHOTOPRINTER
Dyelines in 7 Seconds

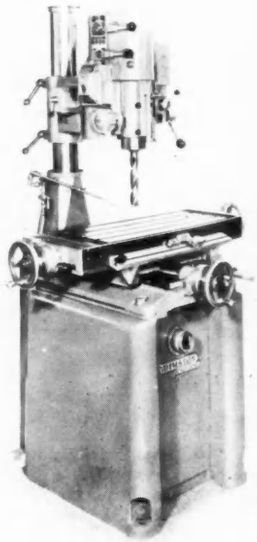
THE Zephyr is a semi-automatic combination printing and ammonia developing machine for taking copies at high speed from drawings made on translucent papers or tracing linen. It will operate at all speeds from 0 to 40 ft per min and has an effective working width of 42 in, though tracings 45 in wide can be fed through the machine. It is possible to make a print in seven seconds.

The high speed of operation is made possible by a fan which blows the ammonia on to the unobstructed surface of the printing paper. The arrangement adopted does away with the perforated metal plate or roller used previously which inhibited good penetration of the ammonia and restricted the speed at which clear prints could be made. A uniform brilliance across the full width of the paper is obtained from a 3 kW heavy-duty quartz tubular lamp contained in a ground glass cylinder.

Provision has been made for the easy cleaning of the outside of the glass and every care, including filtering the cooling air, has been made to see that the inside of the glass keeps clean: when necessary, the lamp is easily extracted, so that the glass can be kept quite clean. A safety pedal enables the operator to stop the machine abruptly.

The manufacturers have taken a great deal of care over the designing and styling of the machine: it is as compact as a modern piano. *NIG Manufacturing Company, 3-9 Dane Street, High Holborn, London, WC1.*

DRILLING AND BORING
Small Batch Work



THE Grimston Co-Ordinate drilling and boring machine has been designed for small batch runs and other general work.

The main drilling head, type LE44L, has a drilling capacity up to 1⅛ in in mild steel and eight spindle speeds over the range 90 to 1,460 r.p.m.; also four geared power feeds ranging from 0·0035 in to 0·008 in for each revolution of the spindle. The unit includes a depth scale, automatic trip and spring return to the spindle. When required, the spindle can be used with hand feed only.

The compound table provides a working area of 32 in by 12 in. Movement of the table is by manual operation, and in both directions recirculating ball leadscrews are employed. The longitudinal movement is 20 in and the cross movement 12 in. Handwheels controlling the table movements have adjustable calibrated rings with 0·001 in divisions. *Grimston Electric Tools Limited, Progress Way, Purley Way, Croydon, Surrey.*

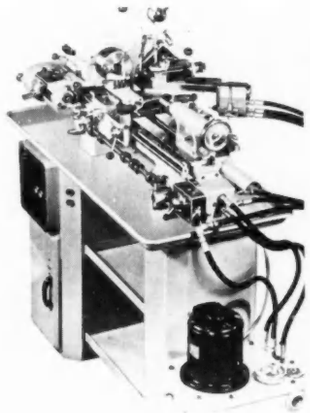
At the

ENGINEERING, MARINE, WELDING AND NUCLEAR ENERGY EXHIBITION

Olympia, 16-30 April

The advances in welding techniques due to the requirements of nuclear plant and the fact that over a third of the exhibitors were in some way connected with this field were two of the points made by Sir Edward Thompson in his opening speech. He also pointed out that at the present time, one in seven of all employed persons in this country was engaged in engineering. A first impression of the exhibition was one of confidence among all sections, and a second of the large number of firms showing hydraulic and pneumatic control systems. Last week we described some of the items on show, and others are considered on this and the following pages.

COPYING LATHE
Designed for Small Parts



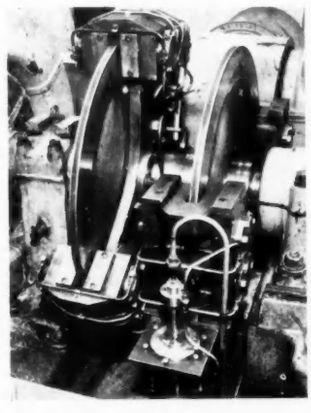
THE Mini-Kop hydraulic copying lathe is designed for the accurate reproduction of small parts. It will take 17½ in between centres and the swing over the slide is 4 in.

The maximum length available for copy turning is 14 in and the swing over the bed is 7 in. Spindle speeds are variable between 50 and 4,000 r.p.m. The top slide travels 4¼ in and swivels through 360°. The lead screw has an Acme thread of ¼ in diameter and 8 t.p.i., enabling threads to be cut from 8 to 56 t.p.i. or from 0·2 to 3·0 mm pitch.

A hydraulic system is used for the carriage traverse, which is fitted with adjustable stops for repetition work, and also for the reproducer system which operates on a valve and plunger stylus mechanism. The stylus return spring pressure is less than 2 lb. This enables soft templates to be used and the unit will reproduce steps as small as 0·0005 in. For cylindrical templates there are adjustable support heads mounted on the flat slotted bar which is used for flat templates.

There are two approach angles for the slide (55 and 90°) which extends the scope for profiling. The single traverse control lever provides slow feed and rapid traverse in both directions. *Myford Engineering Company Limited, Beeston, Nottingham. Stand 11, Row DD, First Floor, Empire Hall.*

DISC BRAKES
Mechanical or Hydraulic Operation



THE Twiflex disc brake utilises the Dunlop calliper unit and can be made in all sizes for industrial drives. It can also be used in conjunction with a clutch as in the illustration.

The disc is normally mounted on a flange on the driving shaft and the calliper unit rigidly fixed on the bedplate. In the calliper unit are two hydraulic cylinders, one on each side, which force the friction pads against the disc. The pads are withdrawn when the brake is released and are self-centering. The use of separate cylinders is a particular feature; it allows better heat insulation and sealing against dust and corrosion.

When hydraulic pressure is used it is usually obtained from an intensifier on the normal low pressure air line. In the example illustrated, which is of a 250 h.p motor, an intensifier using 80 lb per sq. in air boosts the hydraulic pressure to 1,500 lb per sq. in. This brake is designed to absorb 90,000 ft-lb of energy in 0·2 sec.

Particular claims for disc brakes are: the absence of fade; ease of maintenance; automatic adjustment for wear; and capability of absorbing large torques in a comparatively small unit. They will also operate satisfactorily in wet or dirty conditions. *Twiflex Couplings Limited, The Green, Twickenham, Middlesex. Stand 5, Row EE, First Floor, Empire Hall.*

PORTABLE X-RAY
For Plastics, Fibres and Light Alloys

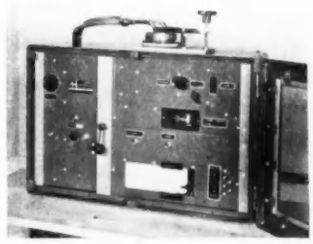
THE 90 kVp type TF1604/1 portable equipment is the latest addition to the Marconi range of industrial X-ray units. A lightweight versatile unit, it is primarily suitable for the examination of plastics, fibrous materials, aluminium and magnesium and their alloys. It comprises a control unit and a tubehead containing the X-ray tube.

The X-ray tube, with 2·1 sq. mm effective focal spot, is mounted in a cast aluminium tank together with the high tension and filament transformers, thus forming a self-contained self-rectifying unit. The tank is oil filled and the complete head is shockproof.

The control unit is complete with line voltage regulator and line voltmeter, with kilovoltage selectors (in 2 kV steps) and with milliampere meter and mA selector. The three milliamperage ranges are preset to values as required. A panel mounted self-resetting synchronous-motor driven timer is fitted.

The weight of the control unit is 90 lb, and the tubehead is 60 lb. Stands for mounting all or part of the equipment can be supplied. *Marconi Instruments Limited, St. Albans, Hertfordshire. Stand 3, Row DD, First Floor, Empire Hall.*

PHOTOMETER
Continuous Measurement of Turbidity



THE Sigrist and Weiss photometer type UP21D employs the principle of continuous comparison of two light beams, emanating from the same source, and measured by the same photo-electric cell.

The light beam is directed alternately between the test cell and the comparison standard by an oscillating mirror. If the light paths are unequal, an alternating current voltage is produced by the photo cell, which is amplified and used to drive a motor that moves a diaphragm in such a sense as to equalise the light arriving at the photo cell from each path.

The measured value is unaffected by fluctuations in the light source, alterations in photocell sensitivity or amplifier drift.

A direct reading of absorption or turbidity is given on a measuring drum coupled to the equalising diaphragm, and a built-in inkless recorder is provided. Remote operation of other recorders, or remote control of the process under investigation, may be effected by potentiometer attachments to the measuring drum shaft. Provision is also included for the closure of internal contacts for alarm purposes.

Absorption and turbidity measurements are carried out by means of a wide range of flow type cells having various path lengths and types of finish for corrosive liquids and gases. True turbidity (nephelometric) measurements are given by the scattered light reading and not by transmission loss. Filters may be inserted for absorption measurements over narrow bands.—*Southern Instruments Limited, Frimley Road, Camberley, Surrey. Stand 17, Inner Row, Gallery, Grand Hall.*

MULTIPURPOSE FILTER
Throw-Away Cartridge

THE Menrow multi-purpose filtering unit can be produced in sizes up to flow rates of 1,400 gallons per hour. It has been designed as a simple unit with a very wide application by the use of filter baskets or candles, micro-screen gauze elements, wire wound strainer elements or throw-away filter cartridges.

The throw-away cartridge consists of a fibre-cellulose cylinder which is produced in a laminated form with layers of three different porosities so that coarse dispersants are trapped on the outer layer and finely micronised dispersants are filtered out by the inner layers. The cartridge is bonded by an epoxy type resin to ensure rigidity before and after use so that it can be very simply extracted after the filtering operation, to be replaced by a fresh cartridge to continue further filtration. Various formulations of this cartridge are available for applications to many duties. *Menrow Limited, 1 Sekforde Street, London, EC1. Stand 28, Inner Row, Gallery, Grand Hall.*

CYLINDRICAL GRINDER

Manual Operation

THE Myford MG12 cylindrical grinder is designed as a low cost high accuracy machine for small workpieces where automatic movements cannot be fully exploited.

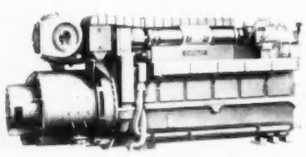
The maximum grinding capacity of the machine is 3 in diameter and the swing over the table is 5 in. The table travel is 13½ in and the table will swivel either way by 5°. There are two feeds: coarse, in which the table moves 2·04 in per revolution of the handwheel and fine in which the movement is 0·7 in. The wheelhead has a total travel of 3 in and the feed graduations are 0·0001 in. The fine feed to dead stop is 0·000025 in and there are two spindle speeds of 2,200 and 2,500 r.p.m. A grinding wheel of 10 in diameter and 1 in face can be accommodated.

The work speeds are arranged in two groups of six, the appropriate range being set by V-belt transfer and the individual speeds by electrical selector switch. No gears in the work spindle drive.

The coolant is circulated by a pump driven by a motor of $\frac{1}{20}$ h.p. The main tank has a capacity of 10 gallons and for high surface finish work there is a separate tank fitted with a separating system. A magnetic filter can also be incorporated. Other extra equipment includes: internal grinding attachment; magnetic filter; workhead collets; wheel dressing attachment; two-point steady; and a range of chucks. *Myford Engineering Company Limited, Beeston, Nottingham. Stand 11, Row DD, First Floor, Empire Hall.*

HIGH PRESSURE DIESEL

Medium Speed



THE Crossley HTBD series are two-stroke engines turbo-charged to 128 lb per sq. in b.m.e.p. The six cylinder version develops 1,350 b.h.p. at 625 r.p.m.

This engine is a newly developed straight-line unit, based on the same cylinder dimensions as the H type, namely 10½ in bore and 13½ in stroke, but designed for high pressure charging. To this end the engine has a substantially strengthened structure with the added safeguard of through-bolt construction, a larger diameter crankshaft, and strip copper-lead tri-metal coated bearings. The cylinder centres/diameter ratio is 1·8 with correspondingly increased connecting rod large end bearing and crankshaft main bearing areas.

Two Root's type rotary blowers are mounted alongside the cylinder block and the turbo-charger is overhung at the driving end of the engine; it delivers air via an intercooler to the rotary blowers which directly feed the air manifold. The fuel pump with directly-coupled governor is also mounted alongside the cylinder block at a high level necessitating only short sprayer pipes and making for a high degree of accessibility—an aim of the whole design.

The engine operates on the port-controlled loop scavenge principle and possesses all the simplicity that this implies; in addition the advantages of exhaust pulse pressure charging are retained. Ease of maintenance, reliability, the capacity for longer runs between overhauls, are claimed as features of this engine, which is shown here in traction power unit form. It is also available for marine and industrial applications. At 750 r.p.m. the six cylinder version of the engine develops 1,500 b.h.p. *Crossley Brothers Limited, Openshaw, Manchester 11. Stand 10, Row G, Ground Floor, Grand Hall.*

MIDGET AIR CYLINDER

1 inch Bore

TO meet the demand for a small, powerful and compact air cylinder Schraders have added to their range a midget type. This cylinder is double-acting with a 1 in bore. It has a 1 in neck mounting thread, with lock-nut for easy assembly in any position.

The cylinder is suitable for operating jigs and fixtures, transfer and special purpose machines. It is said to give long, trouble-free service under fast and arduous working conditions. The cylinder body is of brass and has solid brass endplates of screw-on type with hexagonal flats for easy maintenance.

The piston rod is ground and polished steel. A cartridge type bronze bearing and piston rod seal is incorporated and is replaceable. It is available in six different lengths of stroke—1 in, 2 in, 3 in, 6 in, 9 in, 12 in. The pressure range for the air supply is up to 125 lb per sq. in. *A Schrader's Son, 829 Tyburn Road, Erdington, Birmingham 24. Stand 16, Inner Row, Gallery, National Hall.*

TUBE PROFILE CUTTER

For Workshop or Site

SIMPLICITY is the aim of the Alyn cutter for the production of profiles for pipe branchwork under both site and workshop conditions.

The machine consists of a hollow spindle carrying a self-centering chuck at each end and free to rotate in a head-stock. Attached to the head-stock is an axial motion device on which a flame-cutting blowpipe is mounted.

The axial motion is infinitely variable and will produce a profile on any diameter within the capacity of the machine to suit a main pipe equal to or greater than the diameter of the branch to be cut. In addition to profiles, square cuts can be made.

The selection of the desired profile is by a handwheel, the settings being indicated on a scale on the side of the machine, marked in nominal pipe diameters. No marking off is required as the profile is self-generated. The Mark I machine cuts profiles for 90° branches only. For swept branches or radial cuts, a modified machine is available.

The Mark I machine weighs approximately 80 lb without the stand. It has a capacity of ¾ in to 4 in BSP. The Mark II machine has a capacity from 5 in to 12 in BSP. *Saturn Industrial Gases Limited, Gordon Road, Southall, Middlesex. Stand 4, Row V, Ground Floor, Empire Hall.*

OIL POWERED PUMP

No Crank, No Gears

THE Tangye Hydroflo reciprocating pump operates without a crankshaft or gearing and is claimed to give a more even output than other double acting pumps.

The piston can be made to a very large bore and stroke and will work at high pressures. Models already in use deliver 1,000 gallons per hour at 1,500 lb per sq. in; there are designs for deliveries up to 3,600 g.p.h. at pressures of 6,000 lb per sq. in.

The driving power is supplied by an electric motor direct coupled to a hydraulic pump. The oil is then fed through a sequence and two-speed valve to either side of a plunger which also forms part of the main pump piston. At the end of each stroke the sequence valve reverses the oil supply and so returns the main piston. Thus there is very little fall in pressure at the moment of reversal as the time is short, and the delivery rate is kept nearly constant. A hand-operated pilot valve selects the speed of the main pump. All the working parts are totally enclosed and the instruments and controls mounted on the facia.

The chief claims for the pump are its compact size; its smooth delivery; and its long operating periods without maintenance. On the pumps already installed a period of at least 1,000 hours before overhaul seems possible, and the units weigh only 25 cwt. for a size of 5 ft 2 in long by 2 ft 2 in wide by 3 ft 2 in high. *Tangyes Limited, Cornwall Works, Smethwick, Birmingham. Stand 5, Row J, Ground Floor, Grand Hall.*

EXTINGUISHERS

Foam and Dry Powder Unit

THE RFV1 hose reel foam unit provides "cooling-down" and "smothering" types of media in one appliance.

It consists of a steel container, charged with 1½ gallons of Pyrene foam-making compound and surmounted by a small mechanical foam branchpipe assembly, and is designed to be connected to an ordinary water hose reel, converting it in a matter of seconds into an effective foam-producing unit. The delivery can instantly be changed from foam to water to extinguish freely burning or highly inflammable materials.

The second appliance is the Pyromet dry chemical fire extinguisher designed for use on fires involving such metals as sodium and calcium, or magnesium and aluminium in the form of powder or swarf. The extinguisher is charged with 25 lb of "Pyromet" dry chemical powder, which is discharged under pressure provided by a CO_2 gas cartridge. *The Pyrene Company Limited, 9 Grosvenor Gardens, London, SW1. Stand 11, Outer Row, Gallery, National Hall.*

In Parliament

WELFARE OF FACTORY WORKERS

Consideration was given in the House of Commons one day last week to the Government's new Factories Bill, the House being engaged on this matter—first, on the report stage of the Bill and then on its third reading—from just after half-past three in the afternoon until shortly after midnight.

Mr. Iain Macleod, the Minister of Labour and National Service, moved a new clause to bring railway running sheds within the scope of the Factories Acts. He said that this was the first of 60 to 70 Government amendments. With the exception of the half-a-dozen amendments devoted either to drafting points or to clearing up small defects in the Bill, all the Government amendments had been designed to meet points raised in committee, and were in pursuance of undertakings given either by the Parliamentary Secretary to the Ministry of Labour, Mr. Richard Wood, or by himself. They were points that had been raised during the 17 days—and it was time well spent—that the House had been in committee on the Bill.

At present, railway running sheds were excluded from the operation of the Factories Acts by words contained in Section 151 of the 1937 Act. The new clause would modify that exclusion by providing that premises where running repairs to locomotives were carried out would become factories. All railway running sheds where running repairs were carried out would be included and he was advised that 335 railway running repair sheds would thereby be brought within the scope of the Factory Acts. At the same time, there would still be left outside the scope of the Acts places like sidings, where locomotives were simply cleaned or received minor adjustments and not repairs.

Mr. David Jones (Labour) welcomed the clause but said that the claim to bring within the scope of the Acts other railway installations, such as sidings and places where railway engines were attended to, would be resumed in the near future. Mr. Frederick Lee (Labour) thanked the Minister for introducing the clause, but said that it was only a small dent in the main issues of the Gowers reports which the Government had said for so long that they would implement.

The clause was accepted.

HOT WATER, HOT FOOD

Other new Government clauses moved by Mr. Iain Macleod included provisions that floors, passages, stairs and gangways should be kept free from unnecessary obstruction and from any substance likely to cause persons to slip; that places of work should be made and kept safe for any person working there; and that precautions should be taken against accumulations of explosive or inflammable dust and gas in the surroundings of a workroom as well as in a workroom itself. These clauses were accepted.

A further clause moved by Mr. Macleod specified that adequate washing facilities at factories should include the supply of " hot and cold or of warm water." He referred to this clause as constituting in many ways one of the most important amendments that had been made in the committee stage. In the wording of this new clause, the Government had sought to follow the phrase that was common in many regulations and welfare orders, which had sought to encourage the use of hot or warm water. He regarded this clause as an important and valuable addition to the Bill.

Supporting the new clause " unhesitatingly," Mr. Ellis Smith (Labour) said that it would place a clear responsibility on employers to provide hot and cold water for washing, and on the Ministry's inspectors to see that the clause was operated. He hoped that it would receive the widest possible interpretation, and that it would encourage the provision of ample supplies of clean towels. The clause would have an important effect on the increasing incidence of dermatitis, especially in those industries—such as the ones using fibre-glass—where new materials and new manufacturing processes were being developed. Mr. Gerald Nabarro (Conservative) urged the Minister to have regard to the position that hot water in factories was no less important than hot food in factories. They were complementary. If the Minister regarded it as essential to require all factory occupiers and owners, by statute, to have hot-water supplies, he hoped that the Minister would also extend the principle to hot food supplies.

The clause was approved and, after various other clauses and many amendments had been dealt with, the third reading of the Bill was taken and agreed to.

SCOTS AT LISBON FAIR

Mr. Hector Hughes (Labour) asked the President of the Board of Trade for information about the kind of products which Scottish manufacturers would be sending for exhibition at the Lisbon Trade Fair. He also inquired whether the President had been invited to take any part in the compilation of the Fair's catalogue, with a view to ensuring that justice was done to United Kingdom manufactures. Among the Scottish products on display, said Sir David Eccles, would be ships, marine engines, heating equipment, food machinery, agricultural machinery, pumps, contractors' plant, scientific instruments, textiles and clothing, sports goods, foodstuffs, furniture, glassware and linoleum. The Federation of British Industries were looking after the catalogue and he had every reason to believe that they would discharge that function very efficiently.

RAILWAY WAGON PURCHASES

Questions were put to the Minister of Transport and Civil Aviation regarding the purchasing of new railway wagons. Commander H. Pursey (Labour) wanted the Minister to give a general direction to the British Transport Commission not to buy any more wagons that are fitted with a continental screw coupling, as 135 had been standing in sidings off the Hull-to-Barnsley line for more than 12 months. Mr. Roy Mason (Labour) asked for a direction to the Commission not to buy wagons unsuitably designed for immediate use, in view of the many new wagons standing idle in sidings gradually deteriorating and in need of many modifications before they could be put to productive use.

Mr. Harold Watkinson stated in reply that the design and purchase of wagons were matters for day-to-day management for which the Commission was responsible and he did not feel that he should issue any direction. The Commission had informed him that they were at present negotiating with traders on the future use of the very small number of mineral wagons which were not at present in service.

BUYING FARM MACHINERY

Asked by Sir Alfred Bossom, Bt. (Conservative) about the formation of syndicate credit companies in other counties on lines similar to those started in Hampshire, Mr. John Hare, the Minister of Agriculture, Fisheries and Food, stated that he was encouraging the formation of such bodies, which were mainly concerned with financing the cooperative purchase and use of farm machinery.

This co-operative use made it possible, he considered, for farmers to obtain machinery more cheaply and have the advantage of a wider range of machines. The syndicates now operating in Hampshire and elsewhere had shown that the problems of sharing and servicing machines in joint use could be overcome. Arrangements had been made for the National Agricultural Advisory Service to advise farmers on the setting up of syndicates, and the Agricultural Central Co-operative Association had informed him that they, too, were willing to do that, and also that they were prepared to advise on how to run syndicates.

Railway Modernisation Report

An inquiry is being conducted by the British Transport Commission into the general aspects of the railway modernisation programme and the likely trend of its further implementation. In this connection, Mr. Ernest Davies (Labour) asked the Minister of Transport and Civil Aviation whether any report of the investigation, which the Commission had instigated at the Minister's request, had yet been received. Mr. Harold Watkinson replied that the Commission hoped to let him have their report on the re-appraisal of their modernisation programme during May. He had it in mind to publish the report as soon as possible after its receipt.

Anglo-American Finance

Questions of financial and economic policy are among the functions discharged by the United Kingdom Treasury and Supply Delegation in the United States of America. Mr. J. E. S. Simon, the Financial Secretary to the Treasury, giving this information to Mr. Ronald Russell (Conservative) said that other duties of the delegation included the oversight of matters affecting the staff of missions in North America, staff payments on behalf of all departments except the Foreign Office and Service departments, and certain payments for supplies. The head of the delegation was the Economic Minister at the British Embassy in Washington, and certain members of the delegation also acted as representatives of the British Government in international financial organisations whose headquarters are in Washington, namely the International Monetary Fund, the International Bank for Reconstruction and Development, and the International Finance Corporation.

Electrical Industry's National Approvals Scheme

A statement was asked for by Miss Elaine Burton (Labour) regarding the progress being made by the British Standards Institution on a national approvals scheme in connection with the electrical industry. She drew the attention of the President of the Board of Trade to the position that the matter had been under discussion since October, 1957. Sir David Eccles said that discussions within the industry were still going on. Genuinely difficult technical problems seemed to have arisen but he hoped that they would be resolved within a short time.

Site for Nuclear Power Station

The Paymaster-General was asked by Mr. C. F. H. Gough (Conservative) if he would comment on the proposals to erect a nuclear power station at Earnley. In reply, Sir Ian Horobin, the Parliamentary Secretary to the Ministry of Power, said he understood that the Central Electricity Generating Board were proposing to examine land at Earnley with a view to ascertaining whether it was technically suitable for a nuclear power station. If it should prove suitable, the Board might in due course apply to Minister of Power for his consent to the construction of such a station on the site. At that stage, Lord Mills would consider any representations which might be made to him by interested parties and, if necessary, order a public inquiry before deciding whether or not to give his consent.

Atomic Energy Exhibitions

Information was sought by Mr. Roy Mason (Labour) respecting the intentions of the United Kingdom Atomic Energy Authority to stage provincial exhibitions showing the various industrial uses which have been made of radioisotopes. Mr. Harold Macmillan, the Prime Minister, replied that the Authority was planning a series of three provincial exhibitions later this year. The dates and places had not yet been fixed, but one of the exhibitions would probably be held at Sheffield. They would illustrate all aspects of atomic energy, including many industrial applications of radioisotopes.

Energetic Federation

The annual report of the Federation of British Industries described 1958 as "a somewhat uneasy year." In particular, there was anxiety as to the effects of world recession at a time when the dangers of inflation—though much lessened—were still with us, and disappointment with the "deadlock in the Free Trade Area negotiations." The FBI attempted to make a contribution to the flow of "really up-to-date information" required to guide the Government's policy. To this end they started their "surveys of industrial trends" by circulating a questionnaire to several hundred of their members. These surveys are now held at four-monthly intervals and, says Sir Hugh Beaver in his contribution to the report, the results are "used and studied widely." This new source of information enabled the FBI to submit further evidence to the Cohen Council on Prices, Productivity and Incomes and to the Radcliffe Committee.

The year's work included a wide range of activities, including the usual memorandum to the Chancellor of the Exchequer on taxation (who seems to have adopted the Federation's recommendations the year after they were submitted), a report on nationalisation, studies on Britain's trade relations with Europe, the promotion of export trade (including joint action with the Dollar Exports Council and the sponsoring of the West German retail mission who visited Britain late last year). The Federation's discussions with the Industrial Federations of the countries outside the European Common Market, the "Outer Six," as they have come to be called, may yet achieve positive action towards freer trade.

On the home front the Federation's activities have been numerous: they organised a conference on nuclear energy at Eastbourne, held a well attended series of meetings around the country on the Clean Air Act, strengthened their link with the universities, schools and technical colleges, and generally contrived to provide a forum for the examination of the more complex problems by member trade associations and firms.

British Petroleum Celebrate

Fifty years ago, on 14 April, 1909, the British Petroleum Company was founded under their original name of Anglo-Persian Oil Company. The train of events which led to the company's foundation is the success story of a lucky and energetic gold miner, William Knox D'Arcy. In 1901 D'Arcy, a Devon man, who had made a fortune from gold mining in Australia, was granted a concession by the Persian Government. On 26 May, 1908, the first discovery of oil in the Middle East was made at Masjid-i-Sulaiman in South Persia. The Anglo-Persian Oil Company was formed in 1909 to operate D'Arcy's concession. In 1935 the name was changed to Anglo-Iranian Oil Company and in 1954 to the British Petroleum Company. Last year profits before tax were £168·5 million compared with £151 million in 1957. Group sales totalled 62 million tons.

The BP group are engaged in all phases of the industry, including exploration, production, transportation, refining, research and marketing on a world-wide basis. They have obtained production interests in Kuwait, Iraq and Qatar as well as Persia, and outside the Middle East in Canada, Nigeria, Trinidad and even Great Britain, where BP have producing oilfields in the Midlands. The refining capacity of the company in the United Kingdom now totals 13·5 million tons. Alone or in co-operation with other oil companies BP control refining capacity of 18 million tons in Europe. They own 170 ships totalling 2·75 million deadweight tons and charter some 3 million additional tons from other owners. BP tankers on order or under construction number 48, including seven ships of 65,000 tons. It is almost incredible that so large an organisation could have been built up in 50 years.

BP's expansion continues. They are one of the four companies concerned with the building of a refinery at Mersin in Turkey at the Turkish Government's request. California Texas Oil Corporation, Mobil International Oil Company and Shell Petroleum are the other companies in the group. The Foster Wheeler Corporation of New York have been awarded the engineering contract for the 65,000 barrel-a-day refinery which is due to go on stream in late 1961. The cost is estimated at £50 million.

David Brown and Timken

The David Brown Corporation, Europe's largest gear manufacturers, are proposing to invest $1·35 million in the United States by the purchase of a large minority interest (150,000 shares at $9 each) in Foote Brothers Gear and Machine Corporation of Chicago, with options to purchase an additional 300,000 shares before the end of April, 1965. This would affiliate two of the oldest power transmission equipment manufacturers in each country. The David Brown Corporation, who employ some 10,000 people in 20 factories, are the largest manufacturers of gears in Europe and the Commonwealth. They also make machine tools for the production of gears, farm machinery, tractors and cars.

In the last 15 years Foote's production of gear products has averaged nearly $17 million a year. In addition they produce contract machinery for the steel, chemical processing, sugar, cement, printing and transportation industries and heavy-duty bridge, lock and dam machinery. They are celebrating their hundredth anniversary this year. If the offer is accepted by the Foote stockholders, Mr. David Brown, who is chairman and managing director of the corporation, and Mr. Allan Avison, a deputy managing director, will join the Foote board.

In the reverse direction, an American offer has been made for the control of a British company. The Timken Roller Bearing Company of Canton, Ohio, has offered to buy the 2,337,000 ordinary shares of British Timken they do not own. The offer requires acceptance of 75 per cent of the British shareholders (90 per cent by value). The American company have declared they would not "change in any degree the operations of the British company" but would intensify advertising and sales promotion and link the efforts of both companies in export markets.

Vanguard and After

Intensive test flying of the first Vickers Vanguard turboprop airliner has produced most encouraging results. A cruising speed of 425 m.p.h. is likely to be recommended and there is little doubt that the Vanguard will be the fastest propjet airliner. Up to 9 April the Vanguard had completed 41 flights totalling nearly 100 hours of flying time. Mr. Gordon McGregor, president of Trans-Canada Air Lines, was aboard on a flight lasting five hours and handled the aircraft on take off and landing. His comment was the Vanguard is "as good as the Viscount and twice as big."

Vickers hope that the Vanguard will make its first appearance overseas at Hamburg on 6 May. It is also scheduled to appear at the Paris Air Show in June. The first of British European Airways' 20 machines was rolled out for initial engine trials recently and is due to fly later this month. Three more Vanguards are in the final assembly stage and major components of BEA and TCA machines have been completed.

The English Electric Canberra, which was the first aircraft to fly the Atlantic twice in one day (seven years ago in August, 1952) has been given a place of honour in the National Aeronautical Collection of the Science Museum at Kensington. The nose of the machine will be placed by the side of the Vickers Vimy in which Alcock and Brown made the first non-stop transatlantic crossing 40 years before. The Canberra was powered by two Rolls-Royce Avon turbojet engines. The exhibit will be an interesting illustration of the type of equipment used in the first generation of jet-propelled bomber aircraft of the Royal Air Force before the achievement of supersonic speeds.

The next stage will be the transition from military supersonic aircraft to the supersonic civil airliner. Last week the supersonic transport aircraft committee set up by the Ministry of Supply in 1956, recommended that detailed design work should be undertaken by industry on two first generation supersonic airliners. One would be an aircraft carrying 150 passengers non-stop from London to New York, cruising at over 1,300 m.p.h. (Mach 2) at high altitude. The other, to carry 100 passengers for stage lengths up to 1,500 miles, would be smaller aircraft cruising at Mach 1·2 (about 800 m.p.h.). The cost of developing the second airliner is estimated to be about £100 million.

Tap and Expand

The opening of the British Tap and Die Company's new factory at Edmonton by the mayor of the borough last week was heralded as the signal for the start of "an aggressive and carefully planned drive to increase sales both in this country and overseas." Some 45 per cent of the company's products are currently exported, including a substantial amount sold in the highly competitive American market.

The new factory, which covers 66,000 sq. ft, will have a labour force of 250. Most of the fittings and special purpose machinery have been developed by the company's research and development department. The factory itself was designed and built under the direction of the borough architect and erected within one year of starting by Edmonton's direct labour organisation. It is the latest to be built on Claverings, one of the industrial estates being developed by the Edmonton Borough Council.

Airworthy Caravelle

The French aircraft industry won its greatest success since the war when Sud Aviation's jet airliner Caravelle was granted an airworthiness certificate on 8 April by the American Federal Aviation Agency (FAA). This clears the way for the operation and sale of the airliner in United States territory and, as Sud Aviation point out, constitutes a first-class international reference, being the outcome of prolonged and most exacting tests. The Caravelle is the first pure jet non-American airliner to be granted an FAA airworthiness certificate. This is the third obtained by Sud Aviation within the past 15 months for turbine driven aircraft, the other two being the Alouette and the Djinn helicopters. The Caravelle takes its name from a small light fast ship of the Renaissance period.

Some fifty Caravelles have been ordered so far, by seven airlines, including SAS and Swissair, plus options on a further batch of sixteen. The Alouette was the first French aircraft ever to receive an American airworthiness certificate and the first turbine powered helicopter to be given FAA approval. So far 469 Alouette II have been ordered by 17 countries, including 10 who have adopted it for their armed forces. The licence to manufacture the aircraft has been sold in the United States to Republic Aviation Corporation and in Sweden to SAAB. The Djinn was the first blade-tip jet powered helicopter to receive the FAA certificate. One hundred and thirty units have been sold to 11 countries. Sud Aviation's helicopters are operated at present in 24 countries.

Bread Upon the Waters

A new three-year capital investment programme for advanced technical education has been announced by the Ministry of Education. Local authorities have been advised in a circular that in order to maintain the momentum now building up in the construction of facilities for technical education, a programme of expansion of £15 million will be approved for 1961-62 and the same sum provisionally approved for the following two years. This makes £45 million in all. There will be an additional outlay of £9 million on equipment, bringing the figure to £54 million.

This programme will be grafted on to the end of the £70 million scheme laid down in the 1956 White Paper which set the programme up to 1961. Local authorities will now be able to plan even further ahead. The new programme provides for increases beyond the level of 15,000 advanced science and engineering students laid down in the White Paper. There is to be a further expansion in the educational provision for technicians and craftsmen and there are to be improvements in amenities in colleges as well.

Scholarly Investment

The fifth annual dinner of the FBI overseas scholars held in London last week and attended by the President of the Board of Trade provided an opportunity for reviewing progress. Since the Federation of British Industries started the scheme, 282 scholars have come to Britain from 32 countries. Ninety-one are currently undergoing training and 191 have returned home.

The purpose of the scheme is to see that engineers from developing countries have a full understanding and knowledge of British achievements and British equipment. It benefits all concerned; the scholar is enabled to become a fully trained engineer, his country gains in technical strength, and British industry send back a friend who is knowledgeable concerning the application of British engineering practice and equipment to the development problems of his own country. It is a method very widely employed by industrialised countries to render technical assistance to developing countries and in so doing to spread their influence in those countries and thus secure export business. From the national point of view it is doubtful if a better way exists of promoting good will towards Britain.

The FBI scheme has been highly successful to the extent allowed by the numbers of scholars taken in by industry. Unfortunately the numbers have been very small, ridiculously so if the scale of British exports is taken into account, and small also in relation to the efforts of our main foreign competitors. Although many firms have schemes of their own there is little doubt that the brunt of the work is done by a select few. The load is not spread as it should be. That only 36 scholars should have come from the Middle and Far East in five years (117 from the Commonwealth and 129 from Latin America) is a measure of the inadequacy of the response by industry to the FBI's lead.

Day Rate Bonus

An additional bonus scheme has been introduced for the 5,000 day-rate operatives of the Austin motor works, to bring their pay more into line with that of the 15,000 piece-rate workers employed at the plant. The British Motor Corporation hope that this step will remove a major cause of grievances and disputes.

The scheme was offered to the tractors and transmission branch of the Corporation but was turned down. It was in that branch that a strike by 600 workers, in support of a claim for a substantially-increased bonus for day workers, put nearly 30,000 other BMC employees temporarily out of work. The additional bonus scheme will give day workers 6*d* a week for every penny an hour rise in the average earnings of pieceworkers during a 42½ hour normal working week. Overtime payments are not being taken into consideration.

Building Beckons

A three-day introductory course was organised recently by Wates Limited, the building and civil engineering contractors. It was arranged for final year boys from eight grammar and public schools. The boys came from a selection of schools from points as far apart as Bath, Norwich, Liverpool and Tonbridge.

Lectures were given on various aspects of the company's work including architecture, structural engineering, reinforced concrete, site organisation and quantity surveying. Visits were also arranged to various flats and factories. This was the second course of its kind organised by the company for school leavers.

The building industry has been more criticised over the years than most for its old-fashioned methods and resistance to improved methods of organisation. It is therefore encouraging to see a conscious effort being made to interest school leavers in a career in the building industry. Activities of this kind are bound to have an indirect constructive effect on the industry itself if more concerns follow the Wates example. In the process of putting itself over to young people it must inevitably go through a process of self-examination and rethinking.

Mutation by Segregation

The fourth conference on radioactive isotopes in agriculture at Stillwater, Oklahoma (held under the joint sponsorship of the Associated Midwest Universities and the Argonne National Laboratory) included a paper on radiation and mutations in living tissues. Work on this has been done by Dr. H. E. Kubitschek at Argonne with the use of irradiated bacteria.

In certain cells radiation-induced genetic mutations (which affect hereditarily acquired attributes in living organisms) occur more quickly in some circumstances than in others. Some changes happen at once. In the case of animals, changes may take years. Dr. Kubitschek has used bacteria for experimental work on these variations since their cell structure is simple and because bacteria grow quickly thus giving a high-speed cycle on which to experiment. So far it has been discovered that radiation may not affect genetic material directly. It may induce a chemical mutating agent in another part of the cell and this agent may react on the genetic material at a later date. Even when the mutating agent has found the cell's genes, it may not cause a reaction until a further intermediary reaction has taken place. For a cell to become mutant a process of division called segregation must take place. During this process a daughter cell becomes entirely mutant genetically and after segregation the daughter cell can make the rest of the cell mutant. Even with bacteria, radiation-induced effects do not take place until three cell divisions have occurred. Clearly the study of genetic mutation induced by radiation has only begun.

Cooperate to Educate

Some 30 young Indian engineers have just arrived in this country for training with British steel companies to prepare them for supervisory posts in the Durgapur steel works now being erected in India by a British consortium. This brings the total number of Durgapur trainees who have come to this country to 130. In all, about 300 are expected. The training of senior staff is being provided under the Colombo Plan. The programme of study is organised by the British Iron and Steel Federation and the scheme is administered here by the British Council.

The BISF is also now involved in a co-operative training scheme in Sheffield forges. Much has been said in the last few years about the need for smaller companies to make a contribution in training the country's skilled manpower. This is difficult for concerns with small financial resources, limited staff and no reserve of equipment. The Sheffield forging industry has operated a group scheme since September, 1957. There are now 12 companies joining in. The smallest employs 50 people and the three largest over 5,000 each. A boy spends three days a week in his own company at an agreed starting wage, one day is spent at a separate site where he is taught on the hammer with boys from other companies and the last day is spent at Granville College of Further Education. A hammer has now been bought for communal training. The scheme was planned by managers and training officers of the companies concerned and by the training staff of the BISF.

American Apprentices

In the past decade industrial unions in the United States have taken a keen interest in apprenticeship schemes, which have traditionally been of more interest to craft unions. A detailed scheme has been included in the current agreement between the General Motors Corporation and the United Automobile Workers whereby semi-skilled operatives will have opportunities to advance into skilled trades.

The GM-UAW agreement provides for a formal organisation to make advancement possible and to safeguard the interests of apprentices. A joint skilled trades committee will be established in Detroit composed of three representatives of GM and three representatives of the General Motors department of the international union, UAW-AFL-CIO. This committee will review the uniform training programmes as well as agree to the shop training schedules of the programmes. The unions have the right to appoint an apprentice committee composed of journeymen from the plant, whose task will be to negotiate with management on issues involving the effect of the employment of apprentices on the employment of journeymen in the trades involved; to study and make recommendations on training schedules; and to review the progress of the scheme. The detailed agreement, which breaks new ground in union activities—it is part of a definite trend away from union restriction and control of entry into skilled trades—is a most interesting example of advanced union thinking on such matters.

Limey Discovery

A British engineer, Mr. Roy Smelt, has been appointed by the Lockheed Aircraft Corporation to head the Discoverer satellite launching programme, for which they are main contractors.

A Cambridge graduate, Mr. Smelt began his career at the Royal Aircraft Establishment, where he became an aerodynamics engineer and pioneered the "hotshot" wind tunnel, which made it possible to simulate the hypersonic speeds and ultra-high temperatures of a missile re-entering the atmosphere. In 1948, he became deputy chief of the aero-ballistic research department of the US Naval Ordnance Laboratory. During the war, Mr. Smelt was in charge of the British scientists who examined and evaluated German V1 and V2 rockets, and he directed the flight testing of the first British jet plane.

BRUNEL'S CONTRIBUTION TO BRIDGE ENGINEERING

By P. S. A. BERRIDGE, M.B.E., M.I.C.E.
Assistant Engineer (Bridges)
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The centenary of the opening of the Royal Albert Bridge, Brunel's masterpiece which, as he himself said, joined Cornwall on to the Great Western Railway, is being marked by civic receptions, a church service, an exhibition of Brunel relics at Plymouth and elsewhere, the unveiling of a plaque at Saltash Station, and the switching on of the floodlighting of the bridge on 1 May, 1959. The official opening ceremony of the Royal Albert Bridge was performed on 3 May, 1859, by His Royal Highness, The Prince Consort, as Lord Warden of the Stannaries. In the words of a contemporary, " a stupendous structure, remarkable for the boldness of its conception, and the ingenuity of its construction, the bridge stands a lasting and worthy monument to the skill of the celebrated engineer I. K. Brunel."

The time is opportune to make an appreciation of the part Brunel played in the advancement of engineering and, in particular, to review his contribution to the science of bridge building.

ISAMBARD KINGDOM BRUNEL was born at Portsea on 9 April, 1806. From the age of 17 he was regularly employed in his father's office. At that time they were engaged on a number of designs for suspension bridges, notably two bridges with spans of 122 ft carrying roadways across rivers in the Ile de Bourbon, and others over the Serpentine in Hyde Park and over the Thames at Kingston. Six years later, in 1829, the younger Brunel submitted his first two designs for spanning the gorge at Clifton. These were for spans of 890 and 916 ft respectively and, in competition with no fewer than 22 plans, they were deemed worthy of consideration. Although neither of these bridges got beyond the drawing-board stage, there was no doubt that Brunel made a lasting impression on the committee of the Society of Merchant Venturers. And when later, in competition with Telford, Brunel's design for a 600 ft span was judged preferable to any of the others " the trustees appointed him their engineer."

That was in 1836, and those of us who today may be fidgeting against frustrations which so often seem to bog down the best laid plans, may find comfort in the fact that it was not until 1864 —28 years later and 5 years after Brunel's death —that the Clifton Suspension Bridge, this time with a span of 702 ft, was opened " with much ceremony on 8 December, 1864."

The work at Clifton was stopped altogether in 1853 and the works were sold up. There was the question of the disposal of the chains, and this fact may well have influenced Brunel in his choice of form of construction for the two 455 ft spans of the Saltash Bridge, the design of which was on the drawing-board at that time. Actually the chains from that first Clifton bridge were incorporated in the large spans of the Royal Albert Bridge, and the chains used in the final span at Clifton came from a lesser known masterpiece of Brunel—the Hungerford Suspension Bridge over the Thames near Charing Cross.

The Thames bridge carried a mere footpath 14 ft wide but, nevertheless, with a central span of 676 ft, it was the longest span bridge ever to be built across the Thames. It was constructed between 1841 and 1845, and dismantled just prior to 1860 when work on the Clifton Bridge was actually starting, after having been urged forward by some of the principal members of the Institution of Civil Engineers " who had an interest in the work as completing a monument to their late friend Brunel, and at the same time removing a slur from the engineering talent of the country."

The 300 ft spans of Brunel's bridge across the Wye at Chepstow were the first wrought iron trusses designed to carry a railway across so wide an opening. His previous trusses for railway loading were bowstring girders (they were called bow and string girders in those days), a 100 ft span in a timber viaduct over the Usk at Newport, and the graceful 202 ft span which survives today over the Thames at Windsor. These trusses were formed of a wrought iron polygonal arch of triangular section from which was suspended a horizontal plate girder supporting, on the bottom flange, the cross girders and the timber deck upon which the railway was laid; the plate girder also formed the tie counteracting the thrust at each end of the arch. Diagonal web bracing held the arch against distortion under the passage of the rolling load. For a double line of railway Brunel provided three bowstring girders and fitted top lateral bracings between the arch ribs. The trusses for the Windsor bridge were fabricated in Bristol. Work on site commenced in 1848, the superstructure being erected on temporary timber piling, and the bridge was opened on 8 October, 1849.

At about the same time, Robert Stephenson had been building the high level bridge at Newcastle upon Tyne, and, like Brunel, employed bowstring girders for the six 125 ft spans. That bridge was opened on 15 August, 1849. Apart from the very different forms of construction—the Newcastle bridge carrying three lines of railway on the top deck and a 20 ft roadway below—there was the great difference in materials. Whereas Stephenson favoured cast iron, Brunel built in wrought iron. In a letter to the directors of the Great Western Railway on 18 April, 1849, he wrote:—

" I never use cast iron if I can help it; but in some cases it is necessary, and to meet these I have had girders cast of a particular mixture of iron carefully attended to, and I have taught them at the Bridgwater Foundry to cast them with the flange downwards instead of sideways. By these means, and having somebody always there, I ensure better castings and have much lighter girders than I should otherwise be obliged to have. The number I have is but few, because, as I said before, I dislike them, and I pay a price somewhat above ordinary castings, believing it to be an economy to do so. I won't trust a bridge of castings run in the ordinary way, and at foundries where they have not a person always watching; and, even if I did, the weight requisite in a beam of ordinary metal and mode of running would more than make up for the reduced price."

In the 1840's, Stephenson and Brunel were scheming to build longer spans to carry railways over wider stretches of water; the former was busy on the Britannia tubular bridge over the Menai Straits, while Brunel was engaged at Chepstow. Neither site lent itself to any form of arch construction and it is evident that both engineers, though diffident about its suitability for railway loads, had the suspension bridge very much in the back of their minds. In America, Roebling was spanning Niagara with a suspension bridge of 820 ft for the Grand Trunk Railway to be opened in 1855 with, according to the builder, " no vibrations whatever." In fact, Stephenson originally intended the Britannia tubular bridge with its spans of 230 and 460 ft to have been a suspension bridge, and the piers were built to accommodate the chains. Brunel incorporated suspension chains in his trusses at Chepstow. The possible methods of erection influenced both designers. Stephenson dispensed with chains when he was satisfied that the wrought iron tubular plate girders could be fabricated on the shore and floated out instead of having to be put together piece by piece as they were hung on the chains. Brunel used the chains to build up his trusses after launching

The 455 ft truss spans of the Royal Albert Bridge, Saltash.

The twin spans of the Wye Bridge, Chepstow.

the circular wrought iron tubes across the river and hoisting them to the tops of the supports which had been built to receive them.

Stephenson invited Brunel to assist him in the launching of the tubes for the Britannia bridge (and also for the Conway tubular bridge) and it was through Brunel that Captain Claxton, a close friend, was engaged " to superintend the nautical part of the work " at Stephenson's bridge. Later, Claxton, who became managing director of " the Great Western Steamship Company," was to play a similar role at Chepstow.

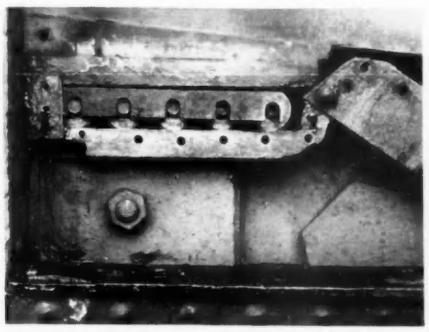
The 300 ft spans over the Wye at Chepstow—there are two of them, one for each railway track—consist of inverted queen post trusses supporting at four places continuous plate girders, and on the bottom flanges of these girders rest the cross girders carrying the timber floor on which the ballasted railway tracks are laid. The trusses, 50 ft in depth and supported on towers through which the trains pass, had to be placed above the railway because at that time there was a considerable amount of shipping on the Wye and the authorities concerned demanded that Brunel should leave a clear headroom of 50 ft under the bridge for navigation. The tubes, 9 ft in diameter, are fabricated of boiler plate, $\frac{3}{4}$ in and $\frac{5}{8}$ in thick, stiffened at intervals by diaphragms in a manner closely following ship practice at that time. It will be remembered that Brunel had built the " Great Britain," his first wrought iron hull and the first large screw-driven steamship, in 1844.

The Chepstow tubes were built on the right bank of the river, which is only a few feet above high water level. They have a camber of 30 in at the centre and when launched they were temporarily trussed to prevent any risk of sagging. Captain Claxton was there to help with the launching. After being manoeuvred into a position at right angles to the river bank, the first tube was mounted on rail-borne trollies and pushed forward until the nose overhung a pontoon of 6 barges moored in the stream. On Thursday, 8 April, 1852, the launching started a little after 9 o'clock in the morning, and by a quarter to ten the pontoon had reached the far bank when " without any delay the chains of the lifting tackles were attached." Indeed there would not have been time to lose because there is a rise and fall of 40 ft in the tides of the Wye and there would be little enough time at slack water.

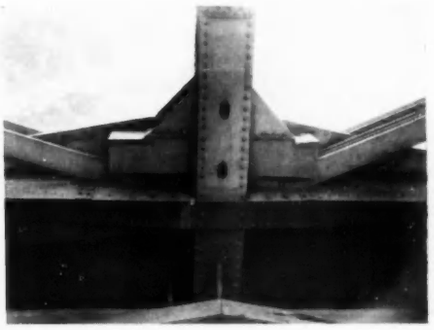
We are told that all proceeded with " perfect quiet and regularity under the management of Mr. Brunel who was assisted by Mr. Brereton and Captain Claxton." The tube was lifted in the course of the day to the level of the railway, and afterwards to its place on the tops of the piers. Evidently the completion of the trusses presented no difficulty for the bridge was opened to single-line traffic on 14 July, 1852.

Details of construction and, in particular, of the connections between the truss chains and the plate girders, are worthy of attention, demonstrating the ingenuity of the designer and the skill—one is almost tempted to say the patience—of the platers and riveters of those days. The bearings of the tubes and the track girders are fixed at the pier in the river, and rollers are provided for expansion on the masonry pier on the abutment. The verticals of the trusses riveted to the tubes or to the plate girders are not free to pivot at their ends under the changing shape of each truss during the passage of a rolling load, but they bear on rollers where the chains pass them. The chains also give support to the plate girders at two intermediate points in the centre portion of the track girders between the nodal points. These supports are in the form of large screws which were used to adjust the tension in the chains. The chains are each formed of batches of links, alternate batches having 12 and 14 links, the links being 10 in deep and varying in thickness from $\frac{11}{16}$ in to $\frac{3}{4}$ in. It is interesting to note that Brunel used considerable perseverance to have these unusually large links, some of which are 20 ft long, rolled in a single piece without welding on the eyes. " He had to go down himself to the manufactory in order to get the men into the way of doing the work."

Today, the trusses are in almost as good a condition as when they were erected nearly 110 years ago. Inside, the tubes emit a creaking sound when a train crosses the bridge, just like a riveted ship in a running sea. The arrangement of the supports to the continuous plate girders gives rise, however, to deformations in the trusses which remain an unfortunate feature of the design. For when a train enters the span and the plate girders deflect under the load between the end of the span and the first nodal point, there is a considerable reduction in the strain imparted by those girders to the chains



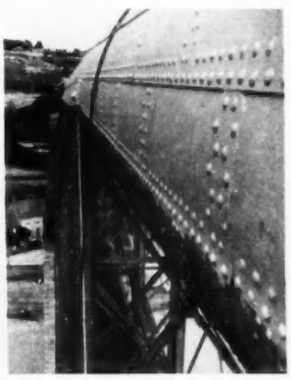
Roller bearings between the chains and a vertical post on the Chepstow Bridge.



Chain arrangements at a nodal point on the Chepstow Bridge.

Triangular compression flange on the Chepstow bridge, an early Brunel design.

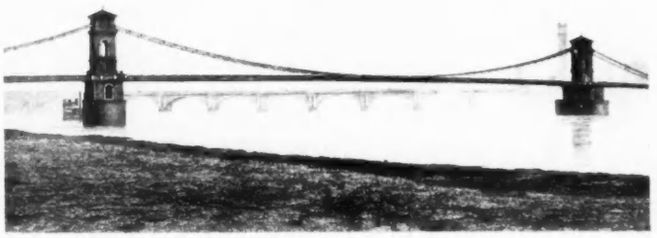
" Balloon " flange (partly cut away) on the Severn Bridge.

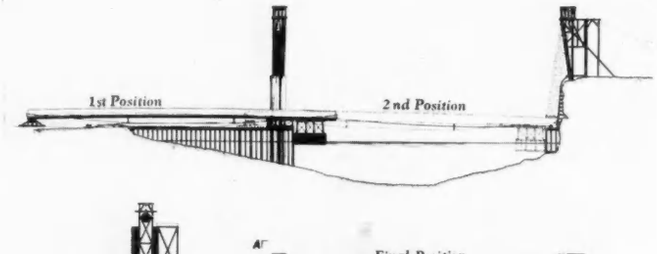


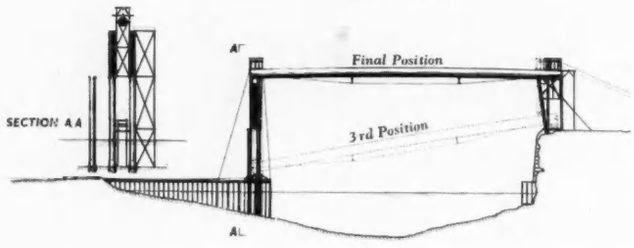
Plating of a tubular chord of the Royal Albert Bridge, Saltash.

Plate girder bridge with " balloon " flange over the River Severn at Gloucester.

Hungerford suspension bridge.







Erection procedure on the Chepstow Bridge.

Lifting the Devon span of the Royal Albert Bridge.

The Saltash Bridge under construction, a remarkable photograph taken 100 years ago, showing the Cornish span raised to its final level, and the Devon span landed on the piers after being floated out.

at the adjusting points near the middle of the span; coming just at a time when the load on the chains is increasing, some change naturally takes place in the shape of the truss. But be that as it may, the fact that this bridge, the first of its kind in the world, is today carrying main-line trains, albeit at a restricted speed of 15 m.p.h., is testimony enough to the skill of its builder.

The Royal Albert Bridge

In the Royal Albert Bridge, his last and most impressive bridge, Brunel again used a combination of suspension chains and tubes for the trusses of the 455 ft spans. The Chepstow Bridge had been finished in 1852 and, no doubt, there was a good deal of scheming by gas-light at 18 Duke Street, Westminster—Brunel's London home and office—as the plans for the bigger bridge got under way in the following year. This time the tube of each truss was given a much greater rise at the centre, equal to the sag of the chains. A continuous web system, consisting of diagonal flats, was also designed to restrain the longitudinal displacement of the 11 verticals under the changing conditions of loading with the passage of a train.

The wrought iron tubes are elliptical in cross-section, 16 ft 9 in broad and 12 ft 3 in in height. The trusses have a depth of 56 ft in the centre and the chains hang so as to leave room for the single line of railway and the track girders below them. Each chain consists of two tiers of links, each tier being formed of 14 and 15 links alternately, and each link being 7 in deep and about 1 in thick. As has already been observed, a portion of these chains were those which had been made for the Clifton suspension bridge, while the balance were supplied by Howard, Ravenhill and Company, of the King and Queen Iron Works, Rotherhithe. The tubes are connected together over the centre pier, and at the other ends they rest on rollers on the tops of the piers.

The trusses remain today virtually as Brunel built them, with the exception of the addition of a longitudinal horizontal brace midway up the verticals and a substantially stronger sway bracing between each pair of verticals. In addition, the decking under the railway track, altered to the standard 4 ft 8½ in gauge in May, 1892, has also been strengthened by a duplication of the cross girders. The approach spans of the Royal Albert Bridge were renewed in 1928-29.

The difficult operations of floating and lifting the superstructures of the Chepstow and Saltash bridges were carried out entirely by Brunel and his assistants, there being no contractor engaged in, or responsible for, the work in either case.

At Chepstow, erection had been piecemeal, the tube being raised first and then the truss built from it. But at Saltash each truss was put together on the Devon shore and parallel with the waterway. The Cornish truss was the first to be completed. After it had been assembled, the ground near the ends was excavated from underneath it and two iron pontoons were placed under the truss. The pontoons carried an elaborate framework of timber, some of the props being 40 ft long, so floating out these great trusses must have been a rather anxious operation.

Brunel directed the first floating personally, and 1 September, 1857, the date chosen, was a beautiful quiet day without any wind. The end portions of the deck girders had been raised and shunted towards the centre of the troughs. This was done to give room for the jacking arrangements while lifting the truss. The total weight of wrought iron work in the superstructure of each span as floated out was 1,060 tons. Each truss was floated out on a rising tide, and after being warped into position over the piers, was landed on the falling tide. Unlike Stephenson at the Britannia tubular bridge, where the piers were brought to their full height before the girders were lifted into position, Brunel built the piers up as the trusses were jacked up stage by stage, 3 ft at a time, at each end. The trusses had to be raised through 87 ft, and this operation took eight months in the case of the Cornish span and five months in the case of the Devon span.

Tubular Compression Members

Brunel also built bridges in brick and in timber. The handsome Wharncliffe Viaduct, with its eight spans each of 70 ft, and the Thames Bridge at Maidenhead, with the two graceful spans of 128 ft each with a rise of only 24 ft 3 in, are fine examples of the use of brickwork. Timber he used for viaducts, particularly on the Cornwall Railway because of its cheapness in first cost. But it was in the use of wrought iron in the fabrication of plate girders and in trusses that Brunel made his greatest impact in the science of bridge construction. He used the best form of strut, the circular tube, for the compression flange of plate girders. In the earlier designs at Chepstow, he built up a top flange that was triangular in section, and when in 1948 the approach spans of the River Wye Bridge were renewed, a portion of one of these old girders was presented to the Institution of Civil Engineers, who placed it alongside part of the balustrade from Rennie's Waterloo Bridge, and the two items are exhibited there together.

Subsequently, improved facilities for bending wrought iron plates led Brunel to use a form of compression flange which was a nearly circular tube. Balloon flanges, some people called them, and among the best examples were his plate girder bridges over the Severn near Gloucester, the last of which was removed in 1958. Finally, to render all surfaces accessible for painting, Brunel evolved the semi-circular top flange, open on the underside, a design he used for spans up to 92 ft in length on the Eastern Bengal Railway in India, and which he also employed for the track girders of the truss spans at Saltash.

The tubes of the Royal Albert Bridge are, like those at Chepstow, fully accessible, and it is a curious fact that while walking through them on a sunny day one may observe on the white-painted soffit of the tube the image of ships sailing under the bridge. For in the lower part of the tubes a few holes—large enough for a starling to fly in, but too small for the pigeons, which find other ways to get inside—have been left in the plating, and when conditions are right, one of these holes acts as the lens of a pin-hole camera formed by the tube.

Brunel was engaged in building the steamship "Great Eastern" at the time the Saltash Bridge was getting under way, and he was prevented from being present during the raising of the second truss in July, 1858. Ill health and doctor's orders took him abroad—in fact Brunel and his friend and rival Robert Stephenson dined together in Cairo on Christmas Day, 1858. He did, however, pay one last visit to see his great bridge before falling once more a victim to the troubles of the great iron ship which eventually brought on the stroke which was to end in his death on 15 September, 1859. Afterwards, in the most moving tribute of all, Daniel Gooch wrote: "On the 15th September I lost my oldest and best friend. . . . By his death the greatest of England's engineers was lost, the man with the greatest originality of thought and power of execution. . . ."

A short time afterwards the directors of the Great Western Railway had placed the inscriptions in large raised letters over the end portals at Saltash:

I. K. BRUNEL
ENGINEER
1859

In so doing they underlined for all time the feelings of admiration which engineers the world over have for the man who built the trusses which will go on carrying trains high above the waters of the Tamar for as long as there are railways there.

EXHIBITIONS AND CONFERENCES

This list, in chronological order, appears in the last issue of each month. Events noticed for the first time and alterations of dates, places, etc., are indicated by an asterisk(*). For details of events not included below, reference should be made to ENGINEERING, *27 February, page 271, and 27 March, page 396. Organisers are invited to send particulars of coming events to the Editor.*

***Institution of Locomotive Engineers, Summer Meeting.**—Tues., 28 April, to Thurs., 30 April, with headquarters at the North British Hotel, Waverley Station, Edinburgh. Offices of the Institution: 28 Victoria Street, London, SW1. Tel. ABBey 6672.

Electronic Parts Distributors Show.—In May, at the Conrad Hilton Hotel, Chicago. Organised by the Electronic Industry Show Corporation, Suite 1500, 11 South La Salle Street, Chicago 3, Ill., USA.

Paris International Trade Fair.—Fri., 1 May, to Mon., 18 May, in Paris. Apply to the French Chamber of Commerce, 74 Brook Street, London, W1. Tel. HYDe Park 2744.

Valencia International Samples Fair.—Fri., 1 May, to Wed., 20 May, at Valencia. Offices: Llano del Real 2, Valencia.

Public Health Education Conference and Exhibition.—Sun., 3 May, to Sat., 9 May, at Düsseldorf. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany.

Agricultural Exhibition.—Sun., 3 May, to Sun., 10 May, at Frankfurt. Organised by Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London, EC4. Tel. CENtral 5050.

TORONTO SHOW

National Industrial Production Show of Canada.—Mon., 4 May, to Fri., 8 May, in the Exhibition Park, Toronto. Sponsored by the Canadian Welding Society, the Canadian Council of Foremen's Clubs, and the American Society of Mechanical Engineers (Ontario Section). *Managers:* E. M. Wilcox, Ltd., 19 Melinda Street, Toronto, Canada.

***Digital Computers, One-Day Conference on.**—Tues., 5 May, at the College of Technology, Birmingham. Fee: £2. Apply to the Registrar, College of Technology, Gosta Green, Birmingham 4.

Dublin Spring Show and Industries Fair.—Tues., 5 May, to Sat., 9 May, at Dublin. Organised by the Royal Dublin Society, Ball's Bridge, Dublin, Eire.

Tokyo International Trade Fair.—Tues., 5 May, to Fri., 22 May, at Tokyo. Organised by the Economic Bureau, Tokyo Metropolitan Government, Marunouchi, GPO Box 1201, Tokyo, Japan.

***Iron and Steel Institute, Annual General Meeting.**—Wed. and Thurs., 6 and 7 May, at Church House, Great Smith Street, London, SW1. Institute's offices: 4 Grosvenor Gardens, London, SW1. Tel. SLOane 0061.

***Institute of Materials Handling, First International Conference.**—Wed., 6 May, to Fri., 8 May, at the Waldorf Hotel, Aldwych, London, WC2. Conference office: 42 Manchester Street, London, W1. Tel. HUNter 2080.

Institution of Plant Engineers, Annual Conference.—Wed., 6 May, to Fri., 8 May, at the Old Swan Hotel, Harrogate. Institution's offices: 2 Grosvenor Gardens, London, SW1. Tel. SLOane 0469.

***Presentation and Interpretation of Technical Information, Conference on.**—Fri., 8 May, at the Connaught Rooms, Great Queen Street, London, WC2 (commencing at 10 a.m.). Organised by Aslib, 3 Belgrave Square, London, SW1. Tel. BELgravia 5050.

***Industrial Safety Conference and Trade Exhibition, National.**—Fri., 8 May, to Sun., 10 May, at Scarborough. Organised by the Royal Society for the Prevention of Accidents, 75 Victoria Street, London, SW1. Tel. ABBey 6963.

United States World Trade Fair, Third.—Fri., 8 May, to Tues., 19 May, at the New York Coliseum, New York, USA. *Managers:* The Charles Snitow Organisation, Inc., 331 Madison Avenue, New York 17. Information may be also obtained from the British Commonwealth Chamber of Commerce in the United States, 677 Fifth Avenue, New York 22. Agents in UK: Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Instrumentation and Computation in Process Development and Plant Design, Symposium.—Mon., 11 May, to Wed., 13 May, in London. Organised by the Institution of Chemical Engineers, the Society of Instrument Technology and the British Computer Society. Address of the Institution of Chemical Engineers: 16 Belgrave Square, London, SW1. Tel. BELgravia 3647.

Liquid Fuels Conference, Second.—Mon., 11 May, to Thurs., 14 May, at Torquay. Theme: "Major Developments in Liquid Fuel Firing, 1948 to 1959." Organised by the Institute of Fuel, 18 Devonshire Street, London, W1. Tel. LANgham 7124.

***European Conference for Industrial Management on Industrial Prospects in Nuclear Energy.**—Mon., 11 May, to Thurs., 14 May, at the Palais des Congrès, Stresa, Italy. Organised by the European Nuclear Energy Agency (ENEA) of the Organisation for European Economic Co-operation. Apply to the information officer, European Nuclear Energy Agency, 38 Boulevard Suchet, Paris 16e.

Self-Service and Shop Equipment Exhibition, First.—Mon., 11 May, to Fri., 15 May, at Olympia, London, W14. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W11. Tel. PARk 7360.

Photo Fair, International.—Mon., 11 May, to Sat., 16 May, at Olympia, London, W14. Apply to British Organisers Ltd., 52 Grafton Way, London, W1. Tel. EUSton 7930.

MACHINE TOOLS

Sydney Machine Tool Exhibition, Second.—Mon., 11 May, to Sat., 16 May, at the Show Ground, Sydney. Organised by the Machine Tool Division, Sydney Chamber of Commerce, 36 Grosvenor Gardens, Sydney, Australia.

Petroleum Exposition and Congress, International.—Thurs., 14 May, to Sat., 23 May, at Tulsa. Information from Mr. William B. Way, 2104 Philtower, Tulsa, Oklahoma, USA.

Budapest Industrial Fair.—Fri., 15 May, to Mon., 25 May, in Budapest. Organised by the Hungarian Chamber of Commerce, Rosenberg hp. u. 17, Budapest.

***Surface Heating by Electricity, Exhibition.**—Wed., 20 May, to Fri., 29 May, at Industrial Development Centre, 83 Paradise Street, Liverpool. Organised by the Merseyside and North Wales Electricity Board, 83 Paradise Street, Liverpool, in conjunction with various industrial firms, including Isopad Ltd., Barnet By-Pass, Boreham Wood, Herts. Tel. ELStree 2817.

Transistors and Associated Semi-Conductor Devices, International Convention.—Thurs., 21 May, to Wed., 27 May, at Earl's Court, London, SW5. Organised by the Radio and Telecommunication Section of the IEE. Apply to the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. TEMple Bar 7676. In connection with this convention, an **International Transistor Exhibition** will be held, also at Earl's Court, from Wed., 20 May, to Thurs., 28 May. Organisers: Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

***Foundry Exhibition.**—Thurs., 21 May, to Sat., 30 May, at Bingley Hall, Birmingham. Sponsored by the Foundry Trades' Equipment and Supplies Association, Ltd. Organisers: Herbert Daniel Exhibitions Ltd., 3 Clifford Street, London, W1. Tel. REGent 8611. (Additional information.)

Swiss Import Exhibition, Third (ZUSPA).—Fri., 22 May, to Sun., 31 May, in Zürich. Offices: Nordstrasse 20, Zürich 6, Switzerland.

Institution of Professional Civil Servants, Annual Delegate Conference.—Mon., 25 May, to Wed., 27 May, at the Leas Cliff Hall, Folkestone. Institution's offices: Queen Anne's Chambers, 28 Broadway, London, SW1. Tel. WHItehall 0436.

AIR CONDITIONING

Heating, Ventilation and Air Conditioning, International Conference.—Mon., 25 May, to Thurs., 28 May, in Paris. Organised by the Institut Technique du Batiment et des Travaux Publics, 6 Rue Paul Valéry, Paris 16e. (Alteration of dates.)

Electro-Heat, Fourth International Congress on.—Mon., 25 May, to Fri., 29 May, at Stresa, Italy. Apply to the British National Committee, 2 Savoy Hill, London, WC2. Tel. TEMple Bar 9434.

Hospital Equipment and Medical Services Exhibition, International.—Mon., 25 May, to Sat., 30 May, at Olympia, London, W.14. Sponsored by the Institute of Hospital Administrators, who will hold their annual meeting at Olympia during the period of the exhibition, and *The Hospital*. The **Institution of Hospital Engineers**, also, will hold their annual meeting at Olympia during the period of the exhibition. *Organisers:* Contemporary Exhibitions Ltd., 40 Gerrard Street, London, W1. Tel. GERrard 4951.

National Education and Careers Exhibition.—Mon., 25 May, to Thurs., 4 June, at Olympia, London W.14. Organised by the National Union of Teachers. Exhibition offices: Hamilton House, Mabledon Place, London, WC1. Tel. EUSton 2142.

***Instrument Exhibition.**—Tues., 26 May, to Fri., 29 May, at the Rutherford College of Technology, Newcastle upon Tyne. Organised by Farnell Instruments, Ltd., Wetherby, Yorkshire.

Business Efficiency Exhibition, 46th.—Mon., 25 May, to Thurs., 4 June, at Olympia, London, W14. Organised by the Office Appliance and Business Equipment Trades Association, 11-13 Dowgate Hill, Cannon Street, London, EC4. Tel. CENtral 1771.

***Dexion Ltd., Exhibition by.**—Tues., 26 May, to Thurs., 4 June, at Stonebridge Park, Wembley, Middlesex. Invitations obtainable from the Sales Manager, Dexion Ltd., Maygrove Road, Kilburn, London, NW6.

Waikato Winter Show.—Tues., 26 May, to Tues., 2 June, at Blendisloe Hall of Agriculture, Hamilton. Agricultural machinery exhibits. Organised by the Waikato Winter Show Association, PO Box 616, Hamilton, New Zealand.

Royal Ulster Agricultural Show, 92nd.—Wed., 27 May, to Sat., 30 May, at the King's Hall, Belfast. Organised by the Royal Ulster Agricultural Society, King's Hall, Balmoral, Belfast. Tel. Belfast 665225.

German Handicrafts and Trade Fair.—Wed., 27 May, to Sun, 7 June, in Munich. Offices: Theresienhöhe 14, Munich 12, Germany. *Agent:* Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Aslib Electronics Group Conference.—Fri., 29 May, to Sun., 31 May, at Ashridge College, Berkhamsted. Limited to 50 delegates. Offices of Aslib: 3 Belgrave Square, London, SW1. Tel. BELgravia 5050.

British Trade Fair in Lisbon.—Fri., 29 May, to Sun., 14 June, in Lisbon, including an **All-British Motor Show.** Organised by the Federation of British Industries, 21 Tothill Street, London, SW1. Tel. WHItehall 6711.

World Petroleum Congress, Fifth.—Sat., 30 May, to Fri., 5 June, at New York Coliseum, New York USA. Offices of the Congress: 480 Lexington Avenue, New York 17, USA. Apply to the British National Committee, Institution of Petroleum, 61 New Cavendish Street, London, W1. Tel. LANgham 3583.

Bath and West Agricultural Show.—Wed., 3 June, to Sat., 6 June, on the Show Site, Yeovil. Organised by the Bath and West and Southern Counties Society, 3 Pierrepont Street, Bath. Tel. Bath 3010.

Helsingborg Annual Trade Fair (Expo Öresund).—Fri., 5 June, to Sun., 14 June, at Helsingborg. Held in collaboration with the Swedish Federation of Commercial Agents. Apply to Helsingborg Exhibitions Co., Ltd., Helsingborg, Sweden.

Material Handling Institute's Exposition.—Tues., 9 June, to Fri., 12 June, at the Public Auditorium, Cleveland. Organisers: Hanson and Shea, Inc., 1 Gateway Center, Pittsburgh 22, Pa., USA.

BUILDING PLANT

Building Plant Exhibition.—Wed., 10 June, to Wed., 17 June, at Greenford, Middlesex. Apply to room 105A, Ministry of Works, Lambeth Bridge House, London, SE1. Tel. RELiance 7611, ext. 1177.

***International Society of Aviation Writers, General Meeting.**—Fri., 12 June, to Fri., 19 June, in Paris. Apply to the Society's secretary-general, 25 Farmcote Road, Don Mills, Ontario, Canada.

Aeronautical Exhibition, 23rd International.—Fri., 12 June, to Sun., 21 June, at Le Bourget Airport, Paris. Organised by the Salon International de l'Aeronautique, 6 Rue Galilée, Paris 16e.

***United States International Book Exhibition, Fourth.**—Sun., 14 June, to Thurs., 18 June, at the Shoreham Hotel, Washington, DC, USA. Takes place at the **1959 Convention and Trade Exhibition of the American Booksellers' Association.** An integral part of the book exhibition will be the **International Periodical Exhibition.** Organisers: A. P. Wales Organization, the European head office of which is 36-38 Southampton Street, London, WC2. Tel. TEMple Bar 8947.

Nuclear and Electronics Congress and Exhibition, Sixth.—Mon., 15 June, to Sun., 5 July, at Rome. Apply Rassegna Internazionale Elettronica Nucleare, Via della Scofa 14, Rome.

Three Counties Agricultural Show.—Tues., 16 June, to Thurs., 18 June, at Malvern. Offices: Malvern, Worcestershire. Tel. Malvern 2231.

***International Conference on the Chemical Arts.**—Tues., 16 June, to Tues., 30 June, in Paris. Offices: 28 Rue Saint-Dominique, Paris 17e.

***Quality in Industry, Conference.**—Thurs. and Fri., 18 and 19 June, at the Palace Hotel, Buxton. Fee: 5 guineas, inc. papers, light refreshments, etc. Organised jointly by the Institution of Production Engineers, the Institution of Engineering Inspection, and the British Productivity Council. Apply to the conference secretary, Institution of Production Engineers, 10 Chesterfield Street, London, W1. Tel. GROsvenor 5254.

Chemical Exhibition, Fifth International.—Thurs., 18 June, to Mon., 29 June, at the Exhibition Grounds, Porte de Versailles, Paris. *Agents in United Kingdom:* Butler's Advertising Service Ltd., 22 St. Giles High Street, London, WC2. Tel. TEMple Bar 5905.

Royal Highland Show.—Tues., 23 June, to Fri., 26 June, in Aberdeen. Organised by the Royal Highland and Agricultural Society of Scotland, 8 Eglinton Crescent, Edinburgh 12. Tel. Edinburgh Central 6106.

***Gases and Volatile Substances, Conference on.**—Thurs. and Fri., 25 and 26 June, in Paris, during the course of the International Conference on the Chemical Arts. Organised by the Institut Français des Combustibles et de l'Energie, 3 Rue Henri-Heine, Paris 16e.

***Electronics Exhibition and Convention, 14th Annual.**—Thurs., 9 July, to Wed., 15 July, at the Manchester College of Science and Technology. Organised by the Northern Division of the Institution of Electronics. Institution offices: 78 Shaw Road, Thornham, Rochdale, Lancs. Tel. Oldham Main 6661.

Underground Machinery Manufacturers Council, Exhibition.—Thurs., 9 July, to Sat., 18 July, at Olympia, London, W14. Sponsored by the Council of Underground Machinery Manufacturers, c/o Peat, Marwick, Mitchell and Co. (P.O. Box 121), 301 Glossop Road, Sheffield 10. Organised by the Municipal Agency, 70 Victoria Street, London, SW1. Tel. VICtoria 9132.

***Great Yorkshire Agricultural Show.**—Tues., 14 July, to Thurs., 16 July, at Harrogate. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton Road, York.

Frankfurt International Autumn Fair.—Sun., 30 Aug., to Thurs., 3 Sept., at Frankfurt. *Agents:* Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London, EC4. Tel. CENtral 5050.

St. Erik's Fair, 17th International.—Wed., 2 Sept., to Sun., 13 Sept., in Stockholm. A feature of this year's fair will be the provision of a "closed" section for capital goods, which will not be open to the general public. Offices: 16-18 Lidingövägen, Stockholm 28, Sweden.

SCOTTISH INDUSTRIES

Scottish Industries Exhibition.—Thurs., 3 Sept., to Sat., 19 Sept., at the Kelvin Hall, Glasgow. *Offices:* 2 Woodside Terrace, Glasgow, C3. Tel. Douglas 9911.

Quebec Provincial Exhibition.—Fri., 4 Sept., to Sun., 13 Sept., at Exhibition Park, Quebec City. Sponsored by the Provincial Exhibition Organisation, Quebec City, Canada.

Brno Trade Fair.—Sun., 6 Sept., to Sun., 20 Sept., at Brno, Czechoslovakia. Organised by the Chamber of Commerce of Czechoslovakia. Information obtainable from the Auger and Turner Group Ltd., 40 Gerrard Street, London, W1. Tel. GERrard 4951.

Utrecht Autumn Fair.—*Consumer Goods:* Mon., 7 Sept., to Sat., 12 Sept., at Utrecht, Holland. Apply to Mr. W. Friedhoff, Netherlands Chamber of Commerce, 10 Gloucester Place, London, W1. Tel. WELbeck 9971.

Packaging Exhibition, Sixth.—Tues., 8 Sept., to Fri., 18 Sept., at Olympia, London, W14. Organised by Provincial Exhibitions, Ltd., City Hall, Deansgate, Manchester. Tel. Deansgate 6363.

European Machine Tool Exhibition.—Sat., 12 Sept., to Mon., 21 Sept., in Paris. Apply to the Machine Tool Trades Association, Brettenham House, Lancaster Place, London, WC2. Tel. TEMple Bar 3606.

Textile Machinery Exhibition, Third International.—Sat., 12 Sept., Mon., 21 Sept., in Milan. United Kingdom firms should apply to Textile Recorder (Machinery and Accessories), Exhibitions Ltd., Old Colony House, South King Street, Manchester 2.

German Industries Exhibition, Tenth.—Sat., 12 Sept., to Sun., 27 Sept., in Berlin. *Agent:* Mr. M. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

ASTM Third Pacific Area National Meeting.—Week commencing Sun., 13 Sept., at the Sheraton Palace Hotel, San Francisco, Calif., USA. Organised by the American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa., USA.

Instrument-Automation Conference and Exhibit, 14th.—Mon., 21 Sept., to Fri., 25 Sept., at the International Amphitheatre, Chicago. Organised by the Instrument Society of America, 3443 South Hill Street, Los Angeles 17, Calif., USA.

SCIENTIFIC FILMS

***International Scientific Film Association, 13th Congress.**—Wed., 23 Sept., to Fri., 2 Oct., in London and Oxford. Organised by the Scientific Film Association, 3 Belgrave Square, London, SW1. Tel. BELgravia 6188.

***Instrument Symposium and Research Equipment Exhibit, Ninth Annual.**—Mon., 28 Sept., to Thurs., 1 Oct., at the National Institutes of Health, Bethesda, Maryland, USA. Sponsored by the Washington, DC, sections of various United States organisations, inc. the American Chemical Society and the Instrument Society of America. Apply to Mr. James B. Davis, National Institutes of Health, Bethesda 14, Maryland, USA.

***Gas Council's Sixth Sales and Service Conference.**—Tues and Wed., 6 and 7 Oct., at the Majestic Hotel, Harrogate. Council's offices: 1 Grosvenor Place, London, SW1. Tel. SLOane 4554.

***Utrecht Machinery and Equipment Fair (Machevo).**—Mon., 12 Oct., to Tues., 20 Oct., in the hall of the Utrecht Fair, Croeselaan site, Utrecht, Holland. Apply to Mr. W. Friedhoff, Netherlands Chamber of Commerce, 10 Gloucester Place, London, W1. Tel. WELbeck 9971.

***Electrical Techniques in Medicine and Biology.**—Tues., 10 Nov., to Thurs., 12 Nov., in the Sheraton Hotel, Philadelphia, Pa., USA. Organised with the approval of the American Institute of Electrical Engineers, the Instrument Society of America, and the Institute of Radio Engineers. Offices of the Institute of Radio Engineers, 1 East 79 Street, New York 21, USA.

***Laboratory, Measurement and Automation Techniques in Chemistry, International Congress and Exhibition on (ILMAC).**—Tues., 10 Nov., to Sun., 15 Nov., at Basle. Exhibition is being organised by the Swiss Industries Fair at their halls at Basle, and application should be made to the Fair authorities. The conference is being organised jointly by the Swiss Association of Automation and the Association of Swiss Chemists, also in the Fair's hall. Apply to ILMAC, 61 Clarastrasse, Basle, Switzerland.

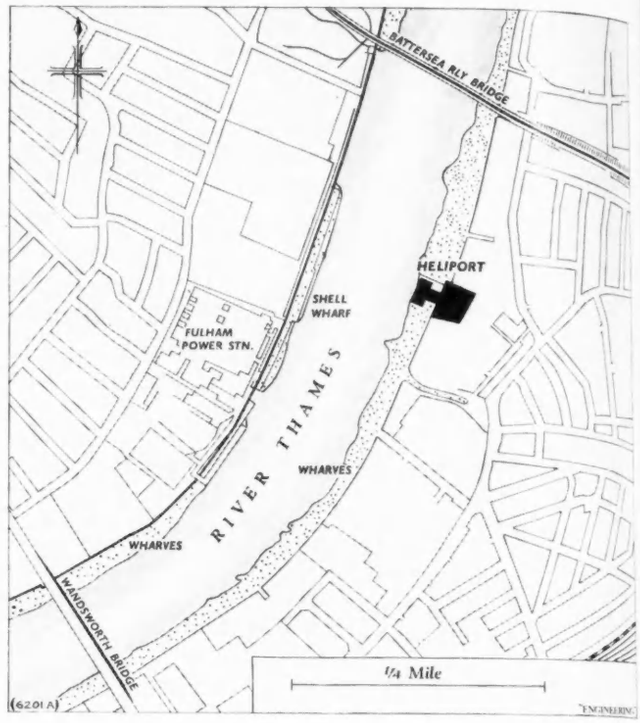
HELIPORT
in the Centre of London

LONDON'S first planned heliport, on the bank of the River Thames at Battersea, was opened on 23 April and traffic handling facilities came into operation on the following day when Bristow Helicopters Limited began a taxi service. It is being built by Westland Aircraft Limited of Yeovil as a private venture to promote the more extensive use of helicopters. It will be operated on a commercially economic basis, revenue being derived from landing and parking fees, and the sale of fuel.

The landing platform is T-shaped and built over the river bed. It has been designed to receive the largest British and American helicopters currently in existence, such as the Westland Westminster and the Fairey Rotodyne. A central administrative building will provide a passenger reception hall and, on prior notice, customs and immigration facilities will be available for the clearance of passengers, their baggage, and also of freight.

Services to be provided will include radio communication and navigational aids, and refuelling, towing and parking facilities for six medium-sized helicopters. Fire-fighting facilities and a rescue launch are also provided. Two car parks on an adjacent site accommodate up to 20 cars.

It will be recalled that planning consent was given for building the Westland heliport following a Public Inquiry held in May, 1958. It was then stressed that the project would serve London's helicopter needs for a temporary period only but that it would enable operational potentialities for the capital to be realised.



Location of the heliport on the Battersea bank of the River Thames.

In February this year Rotorport Limited of London declared that they were ready to go ahead with the construction of a heliport on a disused coal wharf, just west of Vauxhall bridge on the south bank of the river. This site would be about 10 minutes drive from Hyde Park Corner. Permission to proceed is expected shortly.

Meanwhile Westland's heliport, further upstream is to be opened. A very full discussion of the problems associated with the origin, construction and operation of this heliport is to be found in a lecture entitled " Westland's London Heliport " by Wing Commander R. A. C. Brie and published by Westland Aircraft. Much of what follows owes its origin to that lecture.

The basic operating requirements of the helicopter are extremely modest. In daylight, little more space is necessary than will accommodate an unobstructed path for its overhead rotor system though it is very desirable that the site should be free from nearby obstructions such as buildings, trees and pylons.

To comply with bylaws the site has to be at least 400 sq. ft in area and to have unobstructed and well-defined take-off and approach paths over a horizontal distance of half a mile. For the centre of London this virtually restricts the location of heliports to banks of the River Thames. Noise, and its suppression to a tolerable level, is a major problem in a populated area and, at the moment, eliminates from possible use certain sites close to hospitals and offices.

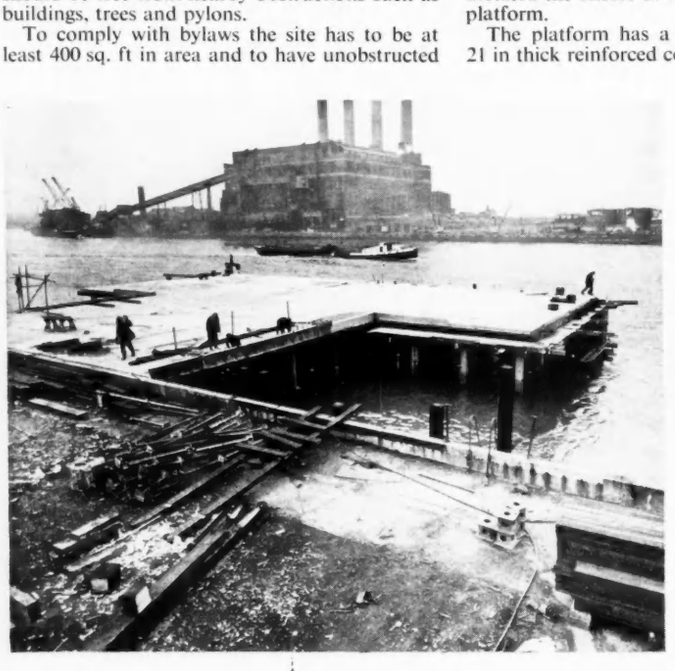
The site chosen for the Westland venture is a plot of land, 200 ft square in area, on the south bank of the Thames, lying between Battersea railway bridge and Wandsworth road bridge and 3½ miles from Hyde Park Corner.

The layout adopted makes use of the on-shore site for all non-flying facilities, including parking, location of buildings and fuelling point. The adjacent riverway, with its unobstructed approaches, is exploited for landings, take-off and associated flight operations. The difference between high and low water, nearly 23 ft, dictated the choice of a rigid rather than floating platform.

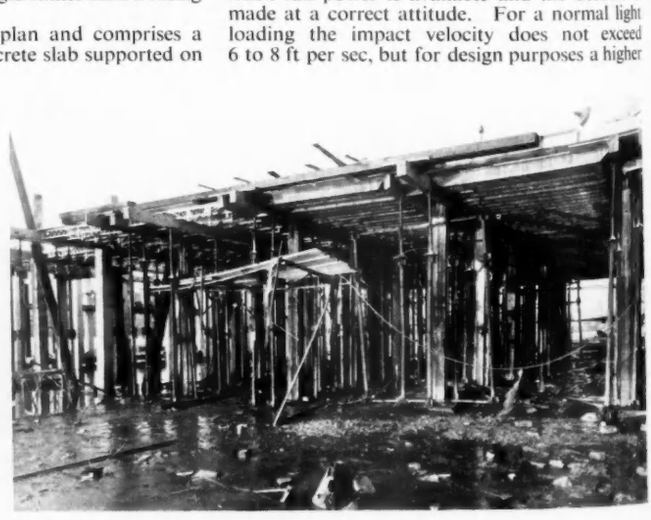
The platform has a T-plan and comprises a 21 in thick reinforced concrete slab supported on prestressed concrete or hollow steel box piles spaced on a 10 ft by 12 ft grid. The hollow steel piles were used under the neck and adjacent to the existing river wall because they were less likely to cause any damage to existing works. All the piles were 45 ft long and driven with a Delmag hammer slung from a derrick. Because the bed of the river consists of 6 in of mud followed by a 13 ft bed of ballast above the clay, the hard driving was met first while much of the length of the pile was still unsupported; steel trestle gates were used to relieve the difficulties that this imposed.

The rectangular head forming the landing and take-off pad has its major axis parallel to the shore line and is 125 ft long by 53 ft wide. The neck, connecting the head to the shore line, is 50 ft long by 65 ft wide. At full spring tides the platform surface is 6 ft above the water.

The impact of a landing helicopter is not high when full power is available and the descent is made at a correct attitude. For a normal light loading the impact velocity does not exceed 6 to 8 ft per sec, but for design purposes a higher



The completed landing platform.



Supports for the shuttering for the 21 in concrete slab which was cast in situ.

figure of 10 ft per sec has been assumed; to take account of impact, a full dynamic load factor of 2·0 was used. Design considerations also include drag loads at the points of tyre contact up to 0·3 of the weight. A helicopter with an all-up weight of 15 tons, such as a Westminster, landing on its two main wheels simultaneously at an impact velocity of 10 ft per sec, was considered when designing the landing slab.

To place the 21 in concrete slab, shuttering of ¾ in plywood was laid over the area. Various means were adopted to support the shutterboard, including timber skirts clamped to the head of the piles, and Acrow centring and props erected above sole plates. The concrete was distributed from a small central batching unit by MonoRail. The mix was a 4 : 2 : 1 of Ferrocrete.

A timber-pile fender system has been installed along the front and part of sides of the platform to give protection against damage from shipping. Impact loads received by the fenders are absorbed by rubber compression pads.

The considerable difference in water level possible at the site made it necessary to provide a slipway to facilitate launching a river rescue boat, an obligatory safety requirement. The slipway runs parallel with the downstream edge of the platform and is set 2 ft above the gently sloping river bed. It is timber decked and carried on piles; 130 ft long, it connects with a stairway at the river wall adjacent to the parking area. The slipway could also provide a convenient walkway for passengers arriving at the heliport by river craft at low tide.

The parking area has been built over the demolished remains of old brick buildings and mixed filling. A hardcore blanket was laid over the area and topped off by 4 in of hot rolled asphalt containing a crushed granite aggregate. The finished gradient is such that there is a uniform cross-fall away from the river. All stormwater is collected at the landward boundary in gulleys and taken back through a falling drain to a petrol and oil interceptor close to the fuel tanks just behind the river wall on the up-stream side of the site. Water is discharged from the interceptor by pump into the river.

Along the up-stream boundary are the two principal buildings. The larger of these is of single-storey construction and is for passengers and staff. It is a wooden prefabricated building, 44 ft long by 30 ft wide, divided off into offices and a traffic-handling area that can be adapted as the needs dictate. Nearby is the combined tractor garage with the control room above, from where the air traffic control officer, equipped with radio and navigational aids, will direct the movement of helicopters. Visual watch is made easier by a balcony built round the building. Equipping of the control room was undertaken by International Acradio Limited, London.

The licence issued by the Ministry of Transport and Civil Aviation permits an operator to use the heliport upon prior notification but also gives the heliport control the power to refuse. To ensure safety over a populated area, flight operations are to be restricted to daylight hours until such times as multi-engined helicopters are available for night work. As there is a possibility that night flying may soon be allowed under conditions of normal visibility, the electrical installations have been designed with this in mind. A minor problem, however, would be the fitting of obstruction lights to tall structures in the locality.

The planning and supervision of all the work associated with the design and construction of the heliport has been the responsibility of the consulting engineers, Messrs. Lewis and Duvivier of London, in association with Mr. H. J. B. Harding, M.I.C.E. The member of the consultants most concerned was Mr. G. W. Rooke, M.I.C.E. Construction work began last August.

The main contractors were W. and C. French Ltd., Buckhurst Hill, Essex; the prefabricated building for offices and passengers and the control tower were built above prepared foundations by W. J. Sims, Sons, and Cooke Limited, Sherwood, Nottingham.

Volta River Project

The Ghana Government have signed a contract for carrying out certain preliminary works for the Volta River combined hydro-electric power and aluminium producing project with the United States firm of Henry J. Kaiser Industries. Initial construction work will include access roads and housing; ground and soil surveys will also be made and a design worked out for the dam and power plant. This action will enable the major project to be begun swiftly if it is decided to proceed. The original assessment of the project was made by Sir William Halcrow and Partners and the reports of the Preparatory Commission were published by the British Government in July, 1956. The Kaiser company have produced a report favourable to the project and making alternative suggestions concerning the location of the dam. The Ghana Government are still hoping to interest aluminium companies in using power from the project.

Northern Approach to Runcorn-Widnes Bridge

The Minister of Transport has approved the construction of a new north approach leading to the Runcorn-Widnes bridge to bypass Widnes. It will cost more than £1 million and a grant of £768,000 has been made to the Lancashire County Council. Work will probably start during the autumn. The new link road will be three-quarters of a mile long and much of it will be constructed on a viaduct with flyovers where it crosses existing roads. It is designed for 7,500 vehicles a day.

Hardcore from Disused Aerodromes

Hardcore for road-making and other contracting work in East Anglia is being obtained from disused aerodromes, many of which were laid down during the war. The St. Ives Sand and Gravel Company Limited have purchased 15 aerodromes and are breaking up the concrete runways, perimeter tracks and aprons for this purpose. This will save the importation of hardcore into the area from elsehwere.

The thickness of the concrete to be broken varies from 6 in to 18 in and two Parker " Rock-Ranger " plants are being used to crush the material. A large proportion of the hardcore is at present going to the new London-to-Yorkshire motorway. The compaction value of the material is said to be very low, less than 10 per cent.

Factory Built Roads

Factory built roads being manufactured and laid in Stuttgart, Germany, are saving four to five weeks in construction time, reducing traffic delays and the duration of detours. The technique has been developed by Herr Otto Winternitz who is in charge of Stuttgart's municipal road department.

While the old surface is being removed and the sub-grade prepared, 8 in thick concrete blocks are cast in the factory and cured. The blocks are set on a pad of bitumen gravel and dressed with a topping of asphalt. As well as effecting savings in urban areas with dense traffic, the system would be of value in countries where heavy-duty road machinery is scarce or for building rural roads.

Tubular Steel Plant in Nigeria

Tubular steelwork for the Arcon buildings used in Nigeria is being fabricated at Lagos, it is announced by Taylor Woodrow (Building Exports) Limited, who distribute the factory-made steel-framed buildings overseas. The workshops established at Lagos and local staff have already produced the first assemblies. The steelwork and tooling required will continue to be sent from the United Kingdom, mainly from the Newport, Monmouthshire, works of Stewarts and Lloyds Limited, the Arcon Group member supplying the tubes. In addition to the two companies already mentioned, the members of the group are ICI, the United Steel Companies and the Crittall Manufacturing Company.

Making Good Concrete

The American Concrete Institute has revised its standard on measuring, mixing and placing concrete (ACI 614-42). Although many of the recommendations are applicable to special concretes, the standard is intended primarily for conventional mixes. The revisions bring the standard in line with high quality work rather than general practice, and illustrations of good and bad practice are included as part of the recommendation. A limited number of pre-prints of the standard are available from the Institute, P.O. Box 4754, Redford Station, Detroit 19, Michigan.

Road Programme in India

By the end of 1971 the Indian Government's long-range road plan will increase the total road length from 331,000 to 657,000 miles, of which about two-fifths will be surfaced. This will give a network of 52 miles of road per 100 sq. miles. The plan will bring every village in developed and agricultural areas within four miles of a metalled road. Expenditure is put at about Rs.5,200 crores (£3,900 million).

SYNTHETIC Rubbers in Bridge Bearings

Extensive use is being made in France of Neoprene in the expansion bearing for bridges. The pads are never more than 1 in thick but several pads have been placed together to increase the thickness, if the load and amount of movement warranted it.

The largest bridge on which these pads have been used is that at Tancarville across the River Seine, 29 km above Le Havre. The bridge has a span of 960 m and the bearings consist of a concrete rocker between two curved concrete bearing surfaces, each member being separated from the other by a Neoprene pad; the bearing assembly is also overlaid and underlaid with the same material

Each pad is 2·29 cm thick and is vulcanised to sheet steel 1 mm thick. The bearings were designed to support a load of 16,000 tons during construction and 10,000 tons after completion of the bridge. Each bearing has to accept a horizontal displacement of ± 4 cm and a rotation of 0·4 per cent.

Low Cost Building Units

A full range of engineered timber products designed to simplify the construction of roofs is to be launched by Dexion Limited at their Building Exhibition at Wembley, Middlesex, from 26 May to 4 June. Known as Tecon products, the range will comprise beams, purlins, gutter units, truss components and decking units. Also on display will be a low-cost building system suited to overseas work, developed jointly by Dexion and Cheecol Processes Limited, Reading.

Service Areas on London-Birmingham Motorway

Proposals are invited by the Ministry of Transport for the development of the service areas at Newport Pagnell and Watford (Northamptonshire) on the London-Birmingham motorway. Both sites have an area of about 5 acres and will be the only points where the construction of petrol stations, catering establishments and other facilities will be permitted along the route.

ARE OIL FILTERS NECESSARY?

By Gordon Wilkins

THE use of centrifugal oil filters on passenger car engines has recently come into prominence through the adoption of a centrifugal filter built into the fan pulley on Fiat cars and the introduction of a new small Glacier filter, the GFO, to supplement the larger types already produced for trucks, tractors and other big engines.

An American investigator recently revealed that over 73 per cent of Soviet tractors employ a two-stage oil cleaner incorporating a centrifugal rotor driven by oil jets based on the British Glacier design which has permitted them to raise their engine oil change period from 100 to 250 hours throughout the Soviet Union, while at the same time achieving a significant reduction in engine wear. Glacier have chosen this moment to produce an analysis which calls into question the premises on which present engine filtration and oil changing practice is based in the passenger car field.

The knowledge that with the high piston speeds and high bearing loads in modern engines particles of only 8 microns can inflict damage, has led to the widespread adoption of pack-type filters, either full-flow or by-pass, but three Continental manufacturers, Renault, Citroen and Volkswagen, continue to enjoy considerable success in export markets and have built up an enviable reputation for engine durability while employing only a simple coarse gauze filter, and two of them build rear-engined cars which appear to suffer a higher level of dust in the engine compartment than front-engined cars.

In fact, experience has shown that oil contamination is not likely to produce excessive wear if it is held below 2 per cent by weight or 3 oz per gal. In passenger cars operating on normal roads with sealed surfaces, dirt accumulates at the rate of about one ounce in 50 hours, so that the danger point is not reached before 150 hours, or about 5,000 to 6,000 miles at average running speeds. So whether the engine has a filter or not, it is argued that contamination is unlikely to reach dangerous levels if the owner changes the oil every 5,000 miles. The type of owner who neglects to change his oil is equally likely to forget to renew the filter element, and a clogged filter will give no protection.

There is of course the possibility of damage in the first few hours of operation on a new engine through the presence of metal particles or sand, left in during assembly, which a full-flow filter would remove, but the experience of the three manufacturers mentioned suggests that modern methods of flushing and blowing out during assembly can reduce this risk to negligible proportions. There remains the need for continuous filtration on cars operating on dusty roads and tracks in undeveloped areas, as also on agricultural machines and civil engineering plant.

For the centrifugal filter it can be argued that the first cost is the last and that it will function at a constant level of efficiency without attention for long periods. The fan pulley filter (British rights for which have been acquired by Vandervell) is cheap, simple and adequate for a large proportion of uses, but is not very accessible for cleaning, and the filter action fluctuates with changes in engine speed.

The separate centrifugal filter with its rotor driven by the reaction of oil jets, is more costly but can be placed anywhere convenient. Its rotation speed is largely independent of engine speed and it is claimed that it quickly reaches a constant level of efficiency where it is holding the level of contamination at that which would be reached in 15 minutes of operation on an unfiltered engine. The small car model operates like the other Glacier models as a by-pass filter, on oil pressures between 15 and 80 lb per sq. in, taking oil circulation through the filter of 10 to 40 g.p.h.

The question remains: is the owner who changes his engine oil every 1,000 miles wasting his money, and are oil filters unnecessary on cars used on modern roads?

VEHICLE STANDARDS

A meeting was held at Geneva from 16 to 20 March of the Working Party on the Construction of Vehicles, a subsidiary body of the Inland Transport committee of the United Nations Economic Commission for Europe. The points under discussion included brakes for trailers and cars; trailer limitations; driving lights and signal lights.

The Working Party expressed a desire to study the different devices used for brake tests in various countries when a new vehicle model is approved. They were of the opinion that the rules for brakes of vehicles on the road should be less strict than for new models. Several countries were in favour of prohibiting any trailer not equipped with brakes, but it was decided to adhere to the requirements of the 1949 Convention, namely, that trailers should be compulsorily fitted with brakes if they weighed more than 750 kg (1,650 lb) or more than half the weight of the towing vehicle. The Party recommended that it should be prohibited for any trailer to be coupled to a two-wheeled motor cycle except in such a way that it improved the stability.

Work had been completed on the text for the regulations for type E asymmetrical headlights and bulbs, and arrangements were made for the preparation of regulations for reflex reflectors. In view of the introduction by American manufacturers of vehicles with four driving lights, the Working Party recommended that the number should no longer be restricted to two, as at present in some countries. For the time being two lights could be regarded as one provided their distance apart did not exceed a specified maximum. The height of passing lights above ground was also dealt with.

A proposal that movable arm indicators should be abolished was rejected by a majority and uniform test conditions were established for visibility—30 metres by day and 300 metres by night. The height above ground for stop lights must in no case exceed 1,900 mm (75 in). Standard maximum and minimum heights were also fixed.

IMPORTS OF FOREIGN CARS

A great deal has been said about the fine performance of the British motor industry in building up exports especially to the United States—a performance well maintained by the recent New York motor show. Much less is heard of the traffic in the opposite direction, the imports of foreign cars into Britain.

The British market is protected by a 30 per cent tariff and by quota restrictions. Last year nearly 11,000 cars came in, mostly from France and Germany. This was a rise of some 2,000 over the previous year. When the free trade area negotiations were grinding to a halt at the end of the year the United Kingdom quotas on cars were given wide publicity. Within the common market the six countries had to let in at least 3 per cent of their home production of cars. For Britain to have done this, if the free trade area had materialised, would have meant an increase from £5·1 million a year to £13·6 million worth of cars from Germany, France and Italy.

Any fears that this would have meant a flood of European cars were allayed somewhat by the fact that in 1958 the actual imports were only £3·5 million; that is, £1·5 million less than the quota allowed. On the whole the European manufacturers do not look on Britain as a good prospect. Purchase tax and duty combine to price them above the popular British cars. The need to make a right-hand drive model for the British market is another complication. In the United States where British and continental cars go in on the same terms the story is rather different.

But although imports of continental cars are small, those from America are negligible. The present quota allows in 650 vehicles a year. In fact the number arriving is only about 300. Two factors may lead to an increase at least up to the quota level in the next two years. One is the liberalisation of dollar imports which may be linked with a bigger car quota. The other is the more technical one that American car designs are changing and some cars are now appearing that could be driven on British roads, and parked in city streets, by drivers of no more than average ability.

The American Motors' Rambler and the Studebaker-Packard Lark, are already making as many sales in the United States as the annual imports from Europe. Ford are now reported to have one and possibly two cars, slightly bigger than the Zephyr, ready to put on the market this autumn. No doubt General Motors and Chrysler also have their carefully publicised secrets. These are the sort of American cars that might sell in Britain. But there is still a long way to go before they get here in any sort of numbers.

COMMONWEALTH MOTORING CONFERENCE

Delegates representing six million motorists from all parts of the British Commonwealth will meet in London from 7 to 13 June to discuss mutual problems and aims.

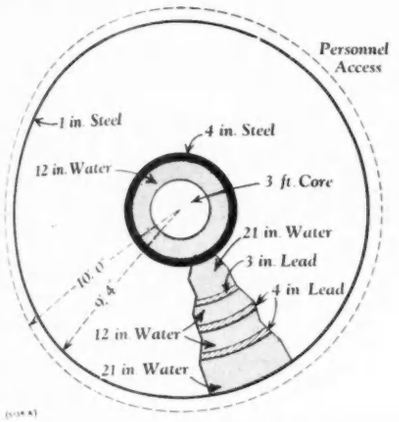
The primary object of the conference, which has been convened jointly by the Royal Automobile Club and the Automobile Association, will be to consider the formation of a projected Federation of Commonwealth Motoring Associations and Clubs which will ensure reciprocal motoring services throughout the whole of the Commonwealth. Invitations to the conference have been extended to 57 overseas motoring organisations.

Topics under discussion will embrace such subjects as the trends of international touring, road safety, technical and engineering services, the development of traffic engineering in Commonwealth countries, the role of motoring organisations in national road development plans and the expansion of small motoring organisations in the Commonwealth.

Both the AA and the RAC already operate reciprocal service arrangements throughout the Commonwealth, and a member of either body is now entitled to the free service of allied organisations. The projected Federation would integrate and extend both these schemes and create the largest corporate motoring organisation in the world.

Marine Nuclear

Two aspects of the Engineering, Marine, Welding and Nuclear Energy Exhibition combine to provide the subject of this week's Atomic Review. As yet nuclear propulsion can only be economic in certain limited circumstances: in ships that require to remain at sea for long periods, such as icebreakers and naval vessels; in ships where byproducts like steam and radioactive isotopes can be profitably used, such as whalers; in submarines where long submerged operation, in particular under ice, may give advantages in running efficiency, shorter routes or winter access; and marginally in oil tankers where the conditions of operation may eventually make an advanced form of nuclear propulsion competitive. As an indication of possible ranges the submarine Nautilus, famous for her transpolar voyage, travelled about 60,000 miles in her first two years of service at speeds between 15 and 20 knots on about 8 lb of nuclear fuel. Probably the most immediate problems to be tackled in conjunction with nuclear ship propulsion are those associated with shielding and safety.



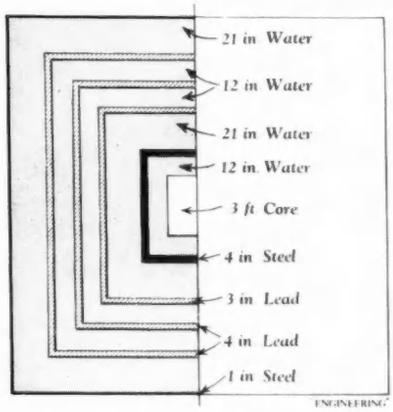


Fig. 1 Top view and vertical section of reactor core shielding designed to reduce neutron intensity by a factor of about 10^{10} and gamma intensity by 10^8.

Shielding for Marine Reactors

"Shielding Aspects of Nuclear Power Plants for Marine Propulsion" was the subject of a paper by H. E. Vann, M. L. Weiss and B. Wolfe, recently presented at a meeting of the (American) Society of Naval Architects and Marine Engineers. The authors considered shielding requirements in general and then treated a specific case for a 20,000 s.h.p. plant. There are two factors which reduce radiation intensity away from the core. One is distance—the radiation intensity dropping off inversely as the square of the distance from the core. The second is the attenuation produced by the shield materials between core and accessible regions. There is a limitless number of possible combinations of materials which can achieve a required attenuation.

Attenuation Formula

In these studies the reactor required to give the necessary output was estimated to emit $7{\cdot}5 \times 10^{16}$ (7 MeV) gamma rays per second and $1{\cdot}1 \times 10^{18}$ neutrons per second (based on 3×10^{10} fissions per sec per watt of thermal power, 2·5 neutrons per fission, and 20 per cent leakage from the core). If the shielding is required to reduce the radiation to 10 mrem per hour at a distance of 10 ft from the core centre then the attenuation factor, A, may be obtained from the formula:

$$A = 4\pi R^2 I K/S$$

where S is the rate of neutron or gamma-ray emission per second, R is the distance in inches from the core centre, and K is a conversion factor from neutron or gamma dose rate per unit area to mrem per hour. (For fast neutrons 1 mrem per hour equals 50 neutrons per sq. in per sec; and for 7 MeV gamma rays 800 rays per sq. in per sec.)

Primary Shielding

Assuming that access is desired during reactor operation to a region 10 ft from the core centre, it can be shown that the shield material must reduce the neutron intensity by a factor of about 10^{10} and the gamma intensity by a factor of about 10^8. From the data given in Table I, a combination of materials may be found which will achieve these attenuations. A shield consisting of about 85 per cent water and 15 per cent lead is shown in Fig. 1, giving a total shield thickness of about 6·5 ft and a shield weight in the region of 700,000 lb. It is important to note that once the shielding materials are chosen, the shielding thicknesses are essentially determined so that the only way to reduce shield weight is to place the heavy high-density material at as small a radius as possible. Experience has indicated that, compared to lead and water, there are no materials available which offer advantages significant enough to warrant the extra cost and difficulties engendered by their use.

TABLE I.—*Approximate Shielding Material Thicknesses in Inches to Attenuate Radiation by Factor of 10*

Principal use	Material	Core gammas during operation (7 MeV)	Fast neutrons	Core shutdown radioactive decay gammas (2·5 MeV)
		In.	In	In
Fast neutron shield	Water	38	9	24
	Polyethylene	38	8	24
	Fuel oil	48	9	30
Gamma shield	Iron (or steel)	4·6	5·5*	3·6
	Lead	2	8*	2·1
Fast neutron and gamma shield	Regular concrete	17·5	10	12
	Barytes concrete	9·4	7·25	7·5
	Magnetite concrete	10	7·5	7·5
	Ferro-phosphorus concrete	7·1	5·75	5·5

* If backed by about 12 to 18 in of water, polyethylene, etc., or when used in laminations of water and steel or lead.

Overall Shielding

In addition to the core shielding it is necessary to provide shielding for the reactor primary-loop equipment and steam generators. The division of the shielding into two elements for this purpose is illustrated in Fig. 2. To this end some 6 in of lead may be taken from its position surrounding the pressure vessel to a cylindrical shell location around the primary-coolant loop and associated equipment. For the 20,000 s.h.p. vessel, the modified shielding weighs 1,400,000 lb as against 700,000 lb for core shielding alone. The increase in weight is largely due to the increased radius at which a substantial thickness of high-density material is placed, not to additional thickness. The extra shielding represents an increase in weight from 35 to 70 lb per s.h.p. The primary shielding must be sufficient to allow maintenance workers to enter the equipment space when the reactor is shut down.

Shielding Materials

Shielding materials considered in a German study comprise reinforced limonite concrete and Repulsit, a gamma-attenuating lead-filled plastic made by Erger and Company, Dortmund.

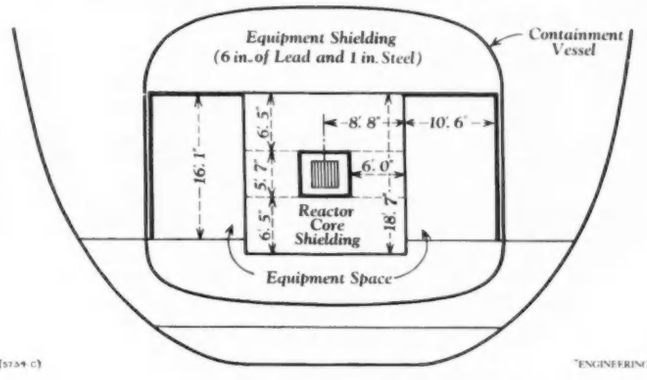
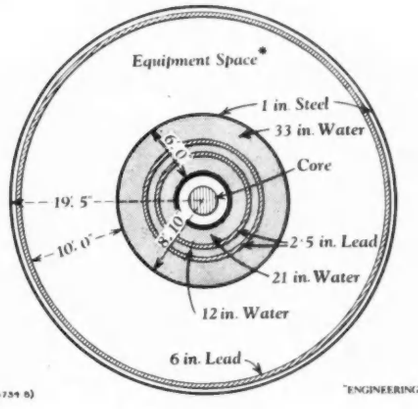


Fig. 2 Diagrams showing core and coolant-loop shielding for pressurised-water reactor marine propulsion plant.



US Naval Ship Propulsion

In addition to the vessels and projects mentioned later, the US Navy has in operation or building 33 nuclear-powered submarines; a guided missile cruiser (2 reactors), Long Beach (11,000 tons); an aircraft carrier (8 reactors), Enterprise (75,000 tons); a 5,000 ton frigate; and a 3,000 ton guided missile destroyer (2 reactors). All employ pressurised-water reactors except the submarine Seawolf; the Seawolf's sodium-cooled reactor is understood, however, to be in process of being replaced with a PWR. This changeover has been undertaken less because of the difficulties associated with sodium coolant and the actual troubles experienced,

than to standardise on training and maintenance facilities. Prototype and test propulsion reactors are as follows: the submarine intermediate reactor mark A S1G sodium cooled (West Milton, dismantled 1957); the Naval reactor facility S1W PWR (NRTS, operating); large ship reactor prototype A1W 2 PWR's (NRTS, operating); submarine advanced reactor prototype S3G PWR (West Milton, operating); small submarine reactor prototype S1C PWR (Windsor, building, operate 1959); and the destroyer reactor prototype D1G PWR (Schenectady, building, operate 1960). Two operating, one building, and four planned reactors are classified and may include propulsion prototypes. By 1966 the US Navy is planning to have a nuclear propelled fleet of carriers, guided-missile cruisers, destroyers frigates and submarines.

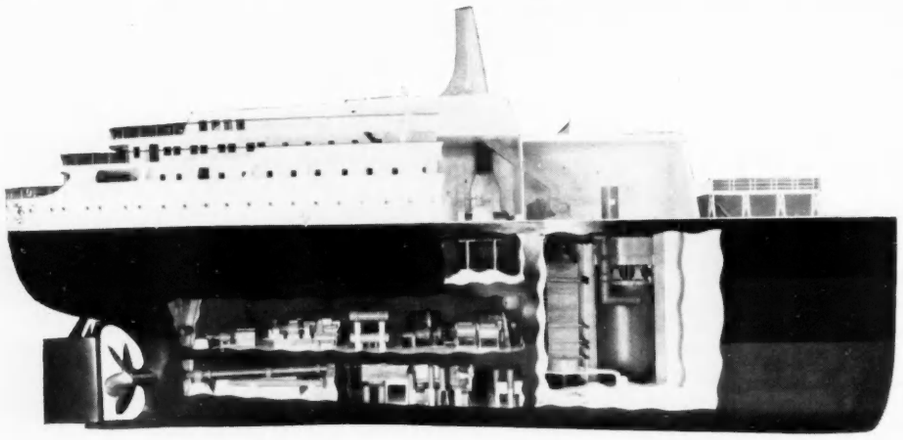


Fig. 3 (above) Model of a 65,000 ton nuclear tanker, cut away to show the advanced gas-cooled reactor. Immediately above the reactor and steam generator are the fuel-element charging machine and the ventilation fan and filter (Vickers Nuclear Engineering Limited).

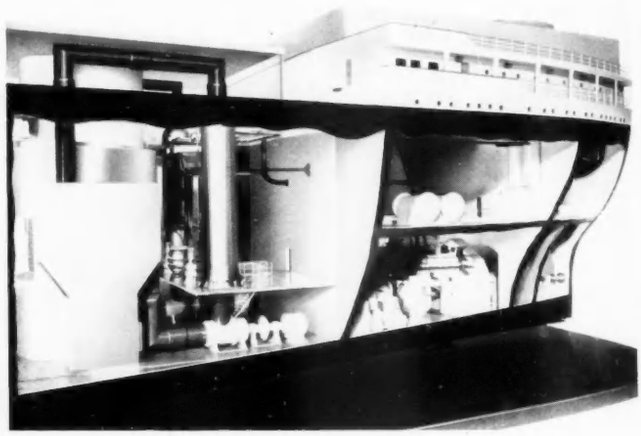


Fig. 4 View of a model representing a section of hull for 60,000 ton tanker showing arrangement of propulsion plant. The gas-cooled graphite-moderated reactor can be seen on the left (Babcock and Wilcox Limited).

Commander and Crew for Dreadnought

The commander and certain members of crew have been selected for Britain's first nuclear powered submarine Dreadnought, the keel of which is to be laid this summer. The commanding officer designate is Lieutenant-Commander B. F. P. Samborne, R.N., and the selected engineer officer is Lieutenant-Commander P. G. Hammersley, R.N. The vessel is to have American propulsion machinery and the US Navy have offered to train about 50 officers and men.

Rolls-Royce and Submarines

Rolls-Royce and Associates, a new company formed in association with Vickers and Foster Wheeler to undertake a variety of nuclear activities (AR 20 Feb.), is reported to be acting on behalf of Rolls-Royce in purchasing from the United States a propulsion unit for the submarine Dreadnought. A naval officer responsible for the project has recently been appointed to Rolls-Royce. The company will be given all the information necessary to permit the design and manufacture of subsequent submarine nuclear propulsion plants in this country. These arrangements form part of the agreement concluded between Britain and the United States. Westinghouse are to supply the plant, which is expected to cost in the region of £10 million. Mr. J. D. Pearson, chairman of Rolls-Royce and Associates, is understood to have said that the company would work on the land-based submarine reactor prototype at Dounreay. Work at Harwell on the basic physics of reactors for nuclear propulsion, in which Rolls-Royce and Vickers-Armstrongs have taken part, has included studies using the light-water cooled and moderated low-energy reactor NEPTUNE, which uses highly enriched uranium. The reactor was also designed by Rolls-Royce in conjunction with AERE.

From Skipjack to Dreadnought

The United States has authorised the transfer to the United Kingdom of a complete Skipjack-type submarine nuclear propulsion plant, spare parts, design and related restricted data. Documents and drawings relating to the reactor plant were recently reported to have arrived at Southampton. Authority for the transfer is contained in the amended Atomic Energy Act of 1954 and in the Mutual Defence Agreement for Co-operation between the United States and the United Kingdom which became effective on 4 August, 1958. The Westinghouse Electric Corporation of the United States has contracted to sell to Rolls-Royce, an agent of the British Admiralty, for installation in the United Kingdom's submarine, Dreadnought, a complete reactor similar to those being installed in the latest US Navy submarines of the Skipjack class. The hull of the Dreadnought has been modified to accommodate the reactor. The machinery is expected to take 2 years to install. A main objective of the transfer is to provide the United Kingdom with technical and manufacturing assistance and knowledge to speed the building of similar submarine nuclear propulsion units for use in the Royal Navy. Vickers-Armstrongs, the British firm which is building the Dreadnought and installing the machinery, will be able to obtain other information and assistance from Electric Boat Company, the United States firm building the Skipjack.

Skipjack Record

What is said to be the highest speed ever attained by a submarine has been recorded by the US Navy's Skipjack during initial trials. The maximum speed of Skipjack is certainly not less than 30 knots and even 50 knots has been suggested. The Skipjack's hull is based on that of the Albacore, which is of whale-like configuration.

Cargo Submarines: Moby Dick

Moby Dick is the provisional name for the nuclear-powered cargo submarine which Mitchell Engineering Limited plan to begin building in 1967. The submarine, which is to be 600 ft long, with a displacement of 50,000 tons, will cost some £20 million, and is to be used for trading with northern Canada. By cruising under the icebound Hudson Bay, it will permit carriage of, say, iron ore, at a time when the seaways are restricted. It is said that the nuclear power plant would develop 75,000 h.p. and operate for 18 months without refuelling. A detailed account of tank tests on proposed Mitchell submarine designs was published in ENGINEERING, vol. 184, p. 738, 1957. Fiat Ansaldo are also said to be planning a nuclear cargo submarine, in addition to a nuclear surface tanker.

Mitchell Cooperate with Fairfield

An agreement has been signed between Mitchell Engineering Limited, and the Fairfield Shipbuilding and Engineering Company Limited for the purpose of working together on the study and development of the use of nuclear energy for marine propulsion and in the design, manufacture and sale of machinery using nuclear energy for the propulsion or auxiliary power of ships. Mitchell Engineering have already gained experience in nuclear power plants for land generating stations and are allied with Combustion Engineering Incorporated, an American engineering firm engaged on large scale research, design and manufacture in this field. The Fairfield Company will contribute their knowledge and experience in the design and construction of ships and in the design and manufacture of geared steam turbine installations.

British Ship Propulsion Project

In Britain the UKAEA in collaboration with the Admiralty and the British Shipbuilding Research Association are studying the type of nuclear propulsion unit which would be most economic for propulsion of a large tanker. Sir John Cockcroft recently drew attention to this programme in a paper, "Nuclear Power for the Propulsion of Commercial Shipping." The possible application of the advanced gas-cooled, graphite-moderated reactor to this purpose has been recently discussed by Iliffe and Moore (Geneva Conference P266). Their conclusions were that fuel costs would be as low as 0·2*d* per s.h.p. hour but that capital costs of the propulsion system would be from 50 to 100 per cent higher than conventional propulsion units. Combining these two components they considered that the nuclear tanker would break even with the oil-fuelled tanker for a displacement of 70,000 tons. A land based AGR nuclear power unit to develop 28 MW of electricity is now being built to test the technology. An alternative system of interest to the United Kingdom would seem to be the boiling-water reactor. Reasonable fuel costs could only be achieved by using by-product plutonium from the future Electricity Board reactors to provide

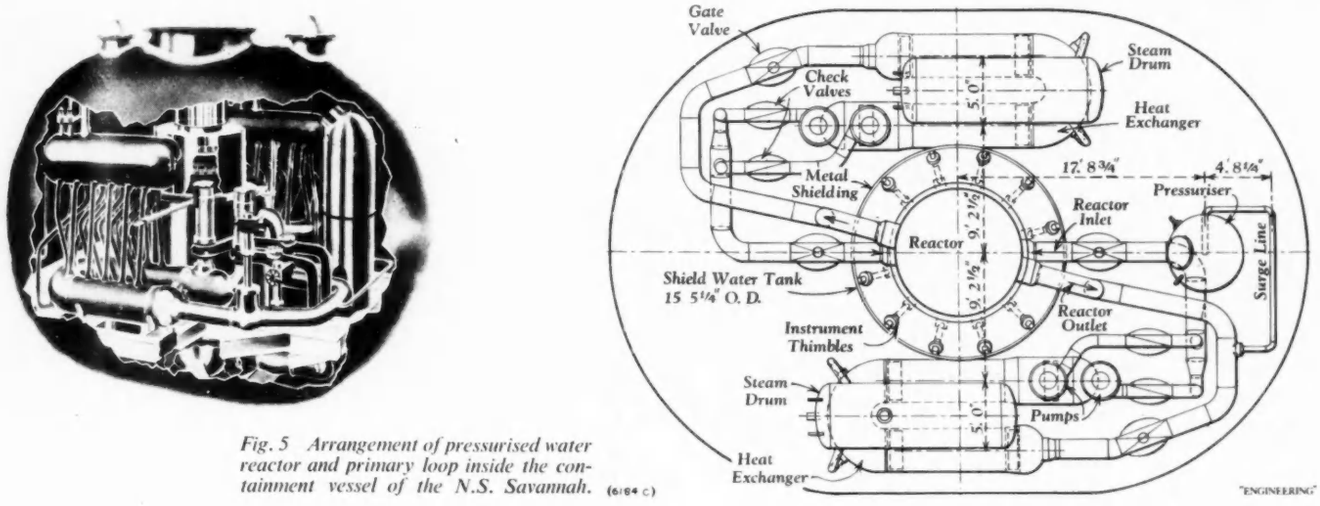


Fig. 5 Arrangement of pressurised water reactor and primary loop inside the containment vessel of the N.S. Savannah. (6/64 c)

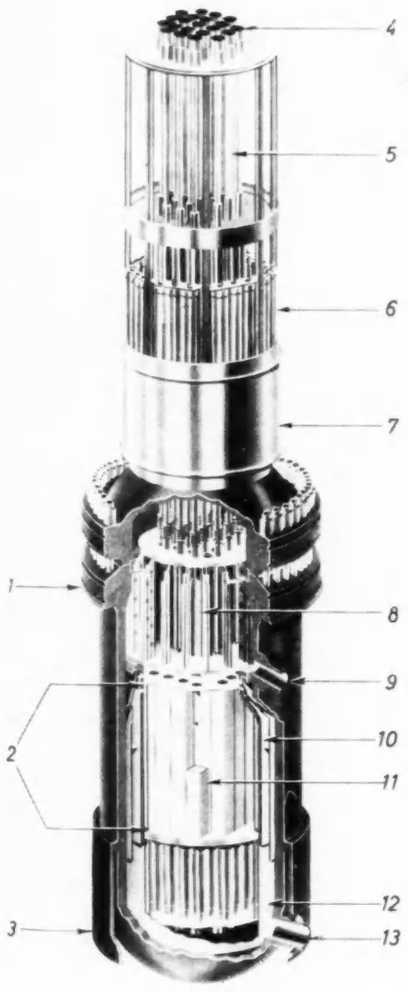
the necessary enrichment. The achievement of low capital costs is the crux of the matter and this can probably only be settled by building a unit.

Glasgow Shipbuilders Study Nuclear Propulsion

Half the staff of the Yarrow-Admiralty research department are reported to be engaged in investigating the application of nuclear power to ship propulsion.

Vickers Propose AGR for Ship Propulsion

Models of marine nuclear power plant systems were shown by Vickers Nuclear Engineering Limited at the Atoms for Peace Exhibition held last year in Geneva. The group is a consortium formed by Vickers Limited, Foster Wheeler Limited, and Rolls-Royce Limited, and has conducted studies of various nuclear power plant systems that might prove suitable for merchant ship propulsion. Models of two such systems were shown, namely, an advanced gas-cooled graphite moderated reactor fitted in a 65,000 ton tanker (Fig. 3); and the nuclear room of a 47,000 ton vessel fitted with a pressurised-water reactor system. Vickers Nuclear Engineering Limited also showed drawings of reactor plant components, which have been designed and manufactured by the group. Among these are steam generators for gas, liquid-metal and water systems; clad and unclad pressure vessels; and examples of high quality techniques for the manufacture of nuclear cooling systems. Test rigs and loops are also designed and built by the group. Finally, there was a model of the swimming pool reactor LIDO, which was built by the group and has been in operation at AERE, Harwell, for shielding studies, since September, 1956.



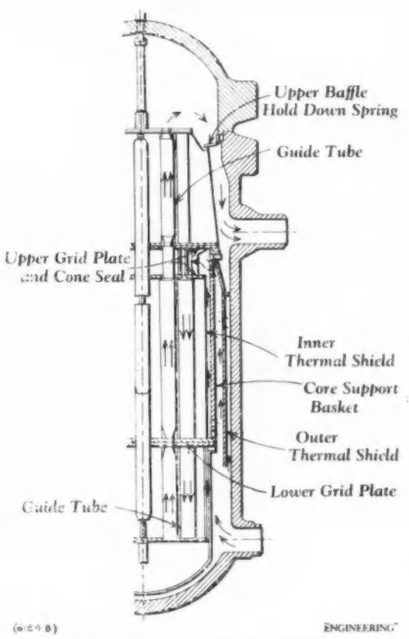


Fig. 6 Cutaway view and half section of the Savannah reactor.

1. Reactor pressure vessel flange.
2. Effective core height.
3. Pressure vessel support skirt.
4. Control-rod electric motor drives.
5. Emergency hydraulic control-rod drive cylinders.
6. Electric drive lead-screw section.
7. Enclosure round control-rod gland seals.
8. Cruciform boron-steel control rod.
9. Water outlet.
10. Internal thermal shields.
11. Rectangular cans containing fuel rods.
12. Flow baffle.
13. Water inlet.

Gas Cooled Ship Reactor

The US Joint Committee on Atomic Energy is said to have received a firm proposal for a 32,700 ton tanker powered by a gas-cooled reactor. The Isbrantsen Company, the Ford Instrument Company (Sperry Rand Corporation), and the Maryland Shipbuilding and Drydock Company have been working on the reactor, and are prepared to continue development studies for a further year. However, the reactor could only be built if federal aid were made available. The group plan to avoid the expensive land-based prototype stage by building the reactor in a separate hull section, testing it, and then inserting the entire section into an existing conventionally powered tanker. The proposed reactor is to be helium cooled, operate at about 950° F (510° C), and provide superheated steam at 640 lb per sq. in abs. and 850° F (450° C).

Higher Thermal Efficiency for Gas Cooled Reactor

The thermal efficiency of gas-cooled reactors used in conjunction with gas turbines can be increased by isothermal expansion of the coolant within the reactor core in suitable cooling channels of variable cross-section, according to an article by F. Winterberg published in *Atomkern Energie* (January, 1959). The surface temperature of the cooling channels should be uniform throughout to obtain optimum efficiency.

Babcock Develop British Marine PWR

Babcock and Wilcox Limited, of London, have been working in conjunction with the Babcock and Wilcox Company of New York to develop a British-made pressurised-water design of nuclear propulsion plant for merchant ships, based on the American Babcock and Wilcox Company's designs. This plant is similar to that being built for the N.S. Savannah. Also, as announced previously, Babcock and Wilcox Limited have, for some time, been collaborating under a non-exclusive agreement, with the shipbuilders, Cammell Laird and Company (Shipbuilders and Engineers) Limited, in feasibility studies on the application of nuclear propulsion to merchant vessels. On the Babcock and Wilcox Limited stand in the Engineering, Marine, Welding and Nuclear Energy Exhibition at Olympia this week, will be seen some details of a typical pressurised-water design, and it is anticipated that during 1959 it will be possible to discuss such designs on a firm basis with interested shipowners and builders at home and overseas. Babcock and Wilcox have also carried out studies concerning the use of gas-cooled graphite-moderated reactors for ship

propulsion, and a model of a 60,000 ton tanker employing this system is shown in Fig. 4.

In a paper "Nuclear Ship Propulsion Prospects in Great Britain," Mr. A. J. Taylor, chief projects engineer in the atomic energy department of Babcock and Wilcox Limited, observes that it "is too early to decide in what manner the advanced gas-cooled reactor designs will be placed on the marine propulsion market, although it is possible that the existing British consortia for land power stations would all be interested in entering the field. It may, however, be some considerable time before competitive tendering organisations already well established in the marine field are set up for this particular design of plant once its feasibility has been established. In the interim period, there may well be scope for firms currently offering American designs and enabling shipowners to gain experience at a reasonable cost."

Savannah Propulsion Machinery

The main propulsion machinery for the single-screw nuclear merchant ship Savannah is reported to have received initial shop tests at the works of the De Laval Steam Turbine Co., Trenton, NJ. De Laval are subcontractors to the Babcock and Wilcox Company (America). Construction is also progressing on the hull at the yard of the New York Shipbuilding Corporation. Details of the ship and its nuclear propulsion machinery are given in the following notes and Table II. (Note: there is some conflict in the published figures. Thus, at the Nuclear Engineering and Science Conference in Chicago, March, 1958, the reactor heat generation was given as 68 MW and the temperature rise through the reactor as 24·6 F (13·7 C). Steam conditions were reported at the Geneva Conference, September, 1958, to be 475 lb per sq. in and 462 F with a flow of 243,500 lb per hour, as against the Chicago figures quoted in the table.)

TABLE II.—*Details of N.S. Savannah*

Hull (Geneva)	
Length overall	595 ft 6 in
Length b.p.	545 ft 0 in
Beam, moulded	78 ft 0 in
Design draught	29 ft 6 in
Total displacement	21,840 tons
Cargo deadweight (approximate)	9,400 tons
Number of cargo holds	7
Number of passengers	60 to 100
Standard of subdivision	2 compartments
Sustained sea speed at design draft and s.h.p.	20,000 20·25 knots
Propulsion Plant (Chicago)	
Shaft power, s.h.p., max. (normal)	22,000 (20,000)
Shaft speed, r.p.m.	110
Turbine inlet pressure (dry, saturated steam), lb per sq. in abs.	460
Main condenser pressure, in of mercury abs.	1·5
Feed-water temperature, F	343
Steam generation:	
For main turbines, lb per hr	204,625
For other uses, lb per hr.	55,325
Total, lb per hr.	259,950
Total electrical load, kW	1,850
Primary water mean temperature, F (C)	508 (265)
Boiler temperature (dry and saturated, F (C)	464 (240)
Reactor Characteristics (Geneva)	
Maximum heat generation, MW	74
Normal heat generation, MW	63
Reactor pressure, lb per sq. in	1,750
Primary water flow, g.p.m. (lb per hr.)	19,800 (8 million)
Primary water mean temperature, F (C)	508 (264)
Temperature rise through reactor, F (C)	22·5 (12·5)
Average heat flux, Btu per hr. per sq. ft.	57,100
Design core life, MWD	52,200
Hence operating life, days	830
Design cruising time at normal power, days	730
Average thermal neutron flux	$8 \cdot 10^{12}$
Enrichment, per cent uranium 235	3·6 to 4

Emphasis has been on safety. The containment vessel, shown in outline in Fig. 5, is designed to withstand a pressure of 185 lb per sq. in and is 35 ft in diameter and 51 ft long, with plate varying in thickness from 1¼ in to 4 in. It supports lead shielding 6 in thick. This capsule, which contains the reactor and core shielding, the primary coolant loops, steam generators, pressuriser, primary circulating pumps and auxiliary systems, is located in a 55 ft compartment amidships, and aft of it is the 67·5 ft machinery space. The reactor pressure vessel is 25 ft 10½ in high with an inside diameter of 8 ft 2 in. The secondary shielding is of polyethylene, lead, concrete and steel, with wood and steel in alternating layers as collision pad. The gross weight of the plant is estimated to be 3,650 tons, of which the reactor (Fig. 6) represents 600 tons, containment and shielding 1,900 tons, and propulsion machinery 1,150 tons. The reactor core, which contains 32 elements each 8·9 in square, is a cylinder of 61 in equivalent diameter by 66 in high, and the fuel is uranium oxide pellets of about 4 per cent enrichment clad in stainless steel (196 rods per element). Control is by 21 cruciform boron-steel rods. The two steam generators are each 20 ft long and contain 800 stainless-steel tubes each ¾ in in diameter. Expected to be completed and the reactor critical in 1960, the Savannah is likely to cost over $40 million, including $22 million for the development and construction of the nuclear plant. The vessel will have a range of 300,000 miles during 3½ years before refuelling. Some 18 kg of plutonium will be recovered per charge.

Lenin on Trial

The Soviet nuclear powered icebreaker Lenin has recently carried out mooring trials in the Leningrad shipyard where she has been built. Her commander, Captain Pavel Ponomarev, has said that the 16,000-ton 44,000-h.p. vessel will be making her maiden voyage "before long." Using uranium fuel of 5 per cent enrichment, the Lenin will not require refuelling for over a year.

The length of the Lenin is given as 134 m, the breadth 27·6 m, and the loaded draught 9·2 m. The speed anticipated is 18 knots, with propeller speeds of 185 r.p.m. (centre shaft) and 205 r.p.m. (outboard shafts). Steam at 310 C will be supplied from the secondary loops of three pressurised-water reactors, one of which is a standby. The weight of nuclear plant will be 3,017 tons, making a total of 5,767 tons for the entire propulsion machinery (240 lb per b.h.p.). The three screws are driven by 1,200 volt d.c. motors, the centre by a double armature 19,600 h.p. motor and the wing propellers each by a 9,800 b.h.p. motor.

Whaling Ship

The use of nuclear propulsion for a whaling factory ship has been examined. It is suggested that an economic feasibility exists in this case, where the reactor can supply propulsive power, process steam and isotopes for the irradiation processing of the whale meat. The proposed reactor is a 35 MW (thermal) pressurised-water type surrounded by a blanket of indium 115 to breed indium 116 for use as an irradiation source. (George K. Brokaw and Robert Gordon, Aerojet-General Nucleonics, Jean Jeffres, Saclay, Balraj Sehgal and Nathan W. Snyder, University of California, *Nuclear Science Abstracts.*)

Boiling Water Reactor for Propulsion

A 22,000 s.h.p. boiling-water reactor propulsion plant has been designed by the General Electric Company (of America) in conjunction with George Shop Incorporated for the conversion of an existing turbine tanker or for a new 39,000 ton ship. Details of the design are given in Table III.

TABLE III.—*Details of Boiling Water Reactor Propulsion Chart*

Reactor rated thermal output, MW	59·7
Total weight of uranium oxide fuel, lb	15,923
Fuel rods per assembly, number	36
Fuel assemblies in reactor core, number	88
Core diameter, in	62·75
Reactor pressure, lb per sq. in	1,000
Saturated steam flow, lb per hr.	205,645
Average heat flux, Btu per hr. per sq. ft	76,108
Net plant thermal efficiency, per cent	27·6

The reactor control system controls reactor power between 10 and 100 per cent of load. The fuel comprises slightly enriched uranium dioxide pellets fabricated as sintered solid cylinders stacked in Zircaloy tubing. The reactor vessel is made of carbon steel clad internally with stainless steel and is designed for a maximum operating pressure of 1,250 lb per sq. in. It is estimated that the cost per ton of cargo carried for a BWR-propelled ship would be $10·80 as against $10·45 for a similar conventional ship. Capital costs are about $11 million and $15 million respectively. Another boiling-water reactor ship study, this time for a 22,640 ton 22,000 s.h.p. vessel, has given the cost of carrying cargo as 21 to 48 per cent higher for the nuclear ship. In this study (symposium, Washington DC, sponsored by USAEC and US Maritime Administration, August '58), three reactor systems were considered. (1) natural circulation, direct cycle; (2) forced circulation, direct cycle; and (3) forced circulation, indirect cycle.

German Organic Moderated Ship Reactor

An agreement to make "joint practical preparations for construction of a commercial ship propelled by an organic-moderated reactor" has been signed between the Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH (Society for Promoting the Application of Nuclear Energy to Shipbuilding and Shipping) of Hamburg and Interatom, a joint subsidiary of Atomics International Division of North American Aviation and Demag. No order has as yet been placed for a ship but a land-based reactor installation, of 40 MW (thermal) power, developing 10,000 s.h.p., may be built at Geesthacht near Hamburg. The plant will be based on designs prepared by Atomics International.

Dutch Nuclear Ship Foundation

Stichting Kernvoortstuwing Koopvaardijschepen (Foundation for Nuclear Propulsion of Merchant Ships) is a research body supported by Dutch shipowners and shipbuilders, the Technical University of Delft, the TNO organisation and the Reactor-Centrum Nederland. The foundation are working on a project for installing a pressurised-water reactor amidships in an existing turbo-electric tanker. The vessel would be chartered not bought, and the reactor would be of United States design. Capital expenditure is estimated at 16 million guilders (£1·5 million), of which 7·5 million would be for nuclear plant and 3·5 million for installation and conversion.

References to Ship Propulsion

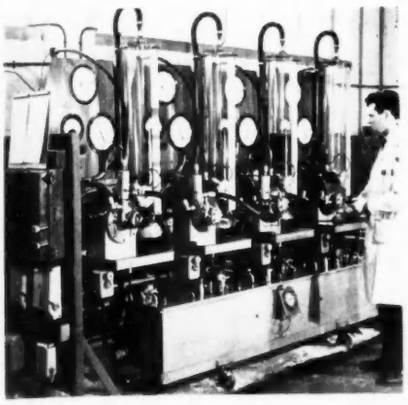
Articles already published in ENGINEERING in connection with ship propulsion include a report by Mr. B. T. Price of AERE, summarising the Geneva Conference papers on this subject published on 7 November, 1958 (vol. 186, p. 600); a similar report on radiation shielding by Mr. J. D. Jones also of AERE (vol. 186, p. 568); and a complete survey of the prospects for nuclear propulsion by Mr. J. Edwards, head of the Naval Section, AERE, Harwell, which appeared on 5 September, 1958 (vol. 186, p. 304). Propelling Ships by Nuclear Power was the subject of an article published in vol 180, p. 859, 1955; and studies for the Mitchell cargo submarine were treated in Underwater Oil Tankers (vol. 184, p. 738, 1957) and Revolutionary Nuclear Engines for Underwater Tankers (vol. 185, p. 470, 1958). Other references to marine nuclear work in Atomic Review are as follows.

Dreadnought and Skipjack 20 March '59; Rolls-Royce and Associates and Vickers Nuclear Engineering 20 Feb. '59; Naval chair of nuclear engineering 13 Feb. '59; US propulsion plants completed, Dutch marine propulsion foundation, Norwegian ship prospect, Dock for Dreadnought 16 Jan. '59; Fiat Ansaldo cargo submarine, Japanese studies 9 Jan. '59; Danatom, West Germany 2 Jan. '59; French submarine reactor, Prototype reactor for US Navy surface vessels 21 Nov. '59; Triton Launched 26 Sep. '58; UK, USA, USSR, and France 29 Aug. '58; UK and US exchange information, Nautilus and Skate, 22 Aug. '58; Operator for Savannah, Transpolar Nautilus 15 Aug. '58; Savannah, Gas-cooled ship reactor 18 July '58; Skipjack, French submarine 4 July '58; Economics of nuclear ships 13 June '58; British groups and companies 16 May '58; US-UK exchanges on ships, Savannah, US tanker, German freighter 11 April '58; Submarine project appointment, Mitchell's naval propulsion reactor 28 March '58; British nuclear ship 21 March '58; Rolls-Royce Dreadnought prototype, Gas-cooled marine reactor 7 Feb. '58; Submarine tanker 3 Jan. '58; Lenin icebreaker, "Nuclear Great Eastern" 20 Dec. '57; Economic comparison 6 Dec. '57; Manoeuvring, Control, Xenon poisoning, Auxiliary plant, Heavy seas, Charging and discharging, Savannah contract, Marine aqueous homogeneous reactor 29 Nov. '57; Neptune critical 22 Nov. '57; Reactors for marine propulsion compared 1 Nov. '57; Neptune 11 Oct. '57; Marine reactors compared 4 Oct. '57; Nuclear powered aircraft carrier 30 Aug. '57; French Q-244 submarine 9 Aug. '57; Nuclear tanker (Hawker Siddeley-John Brown) 19 July '57; US Naval reactors 26 April '57; Nuclear staff for shipbuilding 12 April '57; Turbines for submarine prototype 5 April '57; Nuclear merchant ships, nuclear submarine, nuclear warship, nuclear admiral, Soviet icebreaker 22 March '57; Nuclear ships in Britain 1 Feb. '57; Ships and submarines 25 Jan. '57; Nautilus 18 Jan. '57; Propulsion reports 4 Jan. '57; Ship propulsion survey 24 Aug. '56; Rolls-Royce, Vickers Nuclear Engineering, Lido 29 June '56; Soviet icebreaker 1 June '56; Lido 27 April '56;

HYDRAULIC MECHANISMS

Plessey's New Development Laboratories

THE range of application of hydraulic mechanisms has shown a marked increase in recent years, especially in the field of automatic controls. As a result of this a number of engineering problems of unit and system design have arisen, requiring both factory and field research. To meet these requirements, the Industrial Hydraulics Division of the Plessey Company Limited, Cheney Manor, Swindon, have built a new development laboratory, which, together with a mobile field research unit, is devoted entirely to this work.



Life test rig is designed for 24 hour running with automatic timing and pressure cycling gear.

IN THE FACTORY

The work carried out by the development laboratory is divided into two sections, that of prototype development and that of extended running under controlled conditions to life test the units before release for production. The laboratory is equipped to test all types of hydraulic equipment such as pumps, hydraulic motors with both positive and variable displacement, valve gear, and rams. The rigs contained in the life test section are of a partially set form of construction, allowing little variance of layout, whereas the rigs of the prototype section have been laid down with a view to maximum versatility.

The total machine capacity in the prototype section amounts to 275 h.p., consisting of three 75 h.p. dynamometers and two 25 h.p. dynamometers. Two of the 75 h.p. machines can be coupled to give 150 h.p., and the two 25 h.p. machines can be similarly coupled to give 50 h.p. In order to reduce the ambient noise level for the development staff, the dynamometers have been housed in brick encasements These units operate at speeds up to 3,000 r.p.m., with the power proportional to the speed, and at 3,000 to 5,000 r.p.m. with full power available. The main controls of the dynamometers are suitably positioned immediately in front of the observation windows in the encasement.

Motor rigs in the life test section are of the fixed speed type. A single unit of 75 h.p. may be used in conjunction with a gearbox enabling up to four pumps to be run from one unit. This rig is used for general life testing of the pumps and as a source of fluid power for life testing of control valves and auxiliary hydraulic equipment. A single 30 h.p. fixed speed motor is arranged to transmit power to its driving head through a V-belt and pulley mechanism. This allows some variation in the final output speed. The normal pump life test rig consists of an assembly on which four 20 h.p. motors with individual drive heads are mounted side by side. There is also a ram life test rig consisting of a heavy structure frame on which is mounted a slave loading ram and the ram to be tested. All rigs contained in the life test section are adapted for use with automatic control gear in order to give 24 hour running without attendance.

As the hydraulic fluid varies considerably with the application, portable tanks are used in the prototype section. Built into these tanks is a flow measuring gear either of the cylinder measuring type or the standard electronic flow measuring unit incorporating a positive displacement flow meter. Fluid tanks are also provided with immersion heaters and radiator cooling systems to maintain control of the temperature of the test fluid during operations.

As it is becoming more difficult to measure and inspect component parts of hydraulic units, due to the increased precision now used in production, a section of the laboratory is devoted to the application of precision measuring instruments. The present installation in this section comprises an optical projection unit for the examination of machined forms against master plans, and a Talysurf surface measuring apparatus on which both surface measurements in terms of centre line average, and actual indicated forms by the use of graphical reports can be obtained.

To assist in the preparation of good development reports, a section of the laboratory has been converted into a photographic darkroom. Equipment in the form of a half plate camera, lighting apparatus of both flood and flash type, together with processing equipment, is used to produce photographs of components under test.

Mobile research unit carrying out field test on light agricultural tractor which, to allow freedom, is connected by some 40 ft of electrical cable.

IN THE FIELD

The power and versatility of hydraulic systems has led to their increased use on mobile equipment, particularly on agricultural tractors. Since these often work under widely varying conditions of load, it it important to the designers of the hydraulic systems to have a knowledge of the conditions under which they are to be used, and to have technical data of their behaviour under these conditions. For this purpose, the Plessey Company Limited have converted a Land Rover into a mobile research unit which can be operated in the field to measure the parameters of both pressure and fluid flow on a hydraulic system, whilst working under the most stringent conditions that it is likely to meet.

The measurements of pressures are monitored by electrical transducers giving a voltage output as a function of the pressure. These can then be displayed on two oscilloscopes in the research unit, each having two independent channels with d.c. amplification. For recording purposes, 35 mm strip film cameras are attached to the oscilloscopes, each having film speed ranges of 0·05 to 25 in per second. A photographic processing unit is carried on the Land Rover, so that the films can be developed immediately after each test run; this ensures that the photographic recordings are satisfactory before returning to the factory for a full analysis of the data.

RESEARCH LEADER RETIRES *Kelly of Bell*

Dr. Mervin J. Kelly, chairman of the board of directors of Bell Telephone Laboratories, retired on the first of this month, after 41 years of scientific and administrative service with the largest company in the world. Dr. Kelly began his Bell System career as a research physicist with the research division of the Western Electric Company's engineering department. His early work was in the areas of thermionic emission, gaseous discharge phenomena and electron dynamics and, later, applications of acoustics in telephony. He served as director of vacuum tube development and as development director of transmission instruments and electronics before being named director of research in 1936. He became executive vice-president of the Laboratories in 1944, president in 1951, and chairman of the board in January, 1959.

Dr. Kelly's wide experience extends not only to research and development relating to communications but also to major projects for the armed forces. He led his company's work during the war when they converted almost entirely to military research and development programmes. Since the war he has held many public service assignments in Washington, particularly with the Atomic Energy Commission, the Department of Defence, and the Department of Commerce. He is chairman of a National Academy of Science committee recently formed at the request of the Secretary of Commerce to survey the research development activities of the Department of Commerce. He is also chairman of the Statutory Visiting Committee of the National Bureau of Standards, and is a member-at-large of the Defence Science Board. Dr. Kelly is also active in the field of education. He is a life member of the Massachusetts Institute of Technology Corporation, and a member of its executive committee; a trustee of Stevens Institute of Technology; and serves on advisory committees at MIT, New York University, Case Institute of Technology, Columbia University, and the New York City Board of Education. He is also a member of the New York City Health Research Council.

To honour Dr. Kelly on the occasion of his retirement, the American Institution of Electrical Engineers and Bell Telephone Laboratories have announced the establishment of an annual award for achievement in the field of telecommunications, to be known as the Mervin J. Kelly Award. The first award will be made in 1960. It will consist of a bronze medal, a cash stipend of $1,000, and a certificate.

There can have been few scientists who have achieved or will ever achieve so much in company management. But his success will inspire the multitude of scientists to reach out for a place at the top.

CRYOTRONS *Superconducting Computer Elements*

By J. M. LOCK, Ph.D

Royal Radar Establishment, Great Malvern

ALTHOUGH the word " cryotron " refers strictly to a particular superconducting device operating in a manner similar to the ordinary relay, it is used here as a more general term to cover all the existing devices suitable for use in digital computers and based on the phenomenon of superconductivity. The article begins with a brief summary of the properties of superconductors.

Certain metals when cooled to a very low temperature, usually within a few degrees of absolute zero, quite abruptly lose every trace of their electrical resistance: they are said to become superconducting, and the temperature at which this occurs is known as the transition temperature, T_c, of the superconductor. At any temperature below T_c it is found, however, that it is possible to restore the normal resistance of the metal by the application of a magnetic field larger than a certain critical value, H_c, which increases steadily from zero at the transition temperature to a maximum usually of the order of a few hundred gauss at absolute zero. Because electric currents give rise to magnetic fields it follows also that a large enough current in a superconducting wire can itself restore resistance in the wire, and we can speak of the critical current, i_c, of a superconducting circuit. Except for exceedingly thin wires and films (of the order of 10^{-5} cm diameter or thickness) the critical current of a circuit is just that current which will produce the critical field, H_c, at some point on the surface of the superconductor. All superconducting computer devices must depend on this non-linearity of electrical resistance as a function of either applied field or current.

A digital computer usually needs not just non-linear elements, but devices capable of existing in at least two stable states, and the important feature required is that these two states should be sufficiently different to give adequate discrimination. Now the ratio of normal resistance, R_n, of a metal in a field greater than critical, to its resistance, R_s, in the superconducting state, is infinite, since $R_s = 0$; so we might suppose that the discrimination between these two states, defined as $(R_n - R_s)/(R_n + R_s)$, would be 100 per cent. Unfortunately things do not turn out quite so nicely as this! What we are primarily interested in is computer devices capable of extremely rapid switching from one state to the other, so that it is not just the d.c. impedance, R_s, of the superconducting circuit which matters, but its impedance at high frequencies. This is no longer zero because of the self inductance, L, of the circuit, and it is not difficult to see that the minimum useful switching time of any superconducting device cannot, on this account, be less than about L/R_n.[1]

The cryotron itself (Buck, 1956)[1] was the first superconducting device to be developed, and although it has not so far proved possible to operate it faster than a few thousand cycles per second, it is worth describing in some detail. It consists of a superconducting gate wire, usually tantalum ($T_c = 4{\cdot}4$ K), whose resistance is controlled by the magnetic field of a coil wound on it, made of superconducting wire with a much higher transition temperature. Niobium ($T_c = 8°$ K) is useful for this purpose. Typical dimensions are shown in Fig. 1. The critical field of the gate when operating in a bath of liquid helium boiling at atmospheric pressure (about 4·2° K) is roughly 40 gauss, and the control current needed to restore its normal resistance (only about 0·01 ohm) is about 300 mA. The control winding remains superconducting up to a much higher current than this, and in fact its resistance is zero under all normal operating conditions.

The important feature of the cryotron is that it can be used to control a large current by means of a small one, provided that it is suitably constructed. To do this it is necessary that the field per unit current in the control winding ($4\pi n$, if n is the number of turns per cm) should be greater than the self-field per unit current at the surface of the gate ($4/d$, if d is the diameter of the gate wire). The ratio of these two fields is $\pi n d$, and this quantity, denoted by K, is called the *current gain* of the cryotron. In a cryotron of the dimensions shown, K is about 7. Provided that the current gain of a cryotron is greater than unity, it can be used to control a second identical cryotron, so that cryotrons can be used in logical circuits without the use of additional amplifying devices.

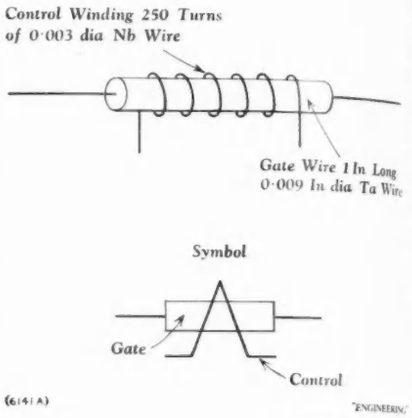


Fig. 1 The cryotron.

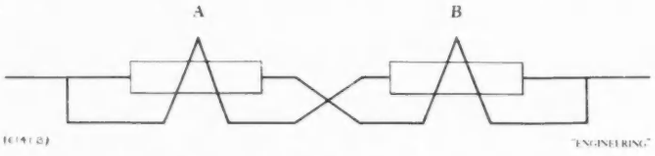


Fig. 2 Basic flip-flop.

The simplest such circuit consists of two cryotrons connected in parallel with the gate of one in series with the control winding of the other, and constitutes a bistable element or flip-flop (Fig. 2). A current supplied from outside can flow either through gate A and control winding B, thus holding gate B resistive, or through gate B and control winding A, thus holding gate A resistive. As it stands, however, our flip-flop has no means of controlling the current path; to do this we need two further cryotrons, C and D (Fig. 3), each with its gate in series with one of the two paths, whose control windings act as " write in " circuits. Furthermore to sense the state of the flip-flop we need two more cryotrons, E and F, each with its control winding in series with one of the two paths, so that their gates, when passing a current, act as " read-out " circuits. The complete flip-flop therefore consists of six cryotrons.

The time taken to switch the current in a cryotron flip-flop from one path to the other depends on the rate at which the current decays when resistance is inserted in the first path by means of a " write-in " pulse. This decay rate is determined by the self-inductance, L, of the control winding and by the normal resistance, R_g, of the gate wire, and it turns out that the complete switching process occupies a time of about $7L/R_g$. Although the dimensions of Dr. Buck's cryotrons are very small, switching still takes about 150 microseconds, and it seems probable, therefore, that the wire-wound cryotron will never be a serious competitor in the field of ultra high-speed computers (switching speeds of less than 1 microsecond, say). An even more serious limitation to the speed of the cryotron is set by the heating which inevitably occurs during the " write-in " pulse, when resistance is first inserted into the arm of the flip-flop which is still carrying current. Since the rate of heating is initially $R_g i^2$, where i is the current carried by this arm, and since it continues for a time of about L/R_g, the total heat generated is always about Li^2. This heat causes warming of the gate wire, and it is found in practice that, because the maximum permissible temperature rise of the tantalum is only about 0·1° K, the switching frequency of the flip-flop is limited thereby to only about a thousand cycles per second.

It seems probable that the same two factors, namely the L/R_n time constant of the circuit, and the Li^2 heat generated per switch, will govern the speed of any superconducting device. In the wire-wound cryotron they are both too large, but a very promising information storage device, based on the use of a thin film superconducting circuit, has been developed in which they are orders of magnitude smaller. This device was invented by J. W. Crowe (1957)[2], and has now been studied in some detail both at IBM in America, and also in this country at the Royal Radar Establishment and at the Services

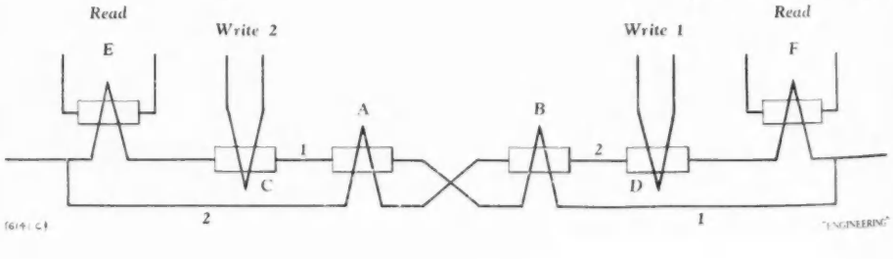


Fig. 3 Complete flip-flop.

Electronics Research Laboratory. It makes use of the possibility of setting up persistent currents in a superconducting circuit, and using the direction of these currents to represent the two states required for information storage.

The Crowe element consists of a thin vacuum-evaporated film of tin or lead, of the shape shown in Fig. 4*a*, on a glass or mica substrate. The two states of the element are represented by currents flowing in the directions shown in Figs. 4*b* and 4*c*, and are set up by current pulses of opposite polarity through the drive wire above the crossbar of film, which is closely linked inductively with the superconducting circuit. Changes of state of the element are detected by means of the pick-up wire beneath the crossbar. Both drive and pick-up wires can themselves be thin evaporated strips of metal separated from the superconducting film itself by evaporated layers of insulator, and in this way their inductive linkage with the superconducting circuit is made as close as possible. Under these circumstances, as long as the film itself remains entirely superconducting, any change in the drive current induces a current in the film which prevents any change of flux through the D shaped holes in the circuit, so that no voltage is induced in the pick-up wire, and no change of state of the element can occur on removal of the drive current pulse. However, if the drive current is increased sufficiently, the induced current in the crossbar reaches the critical current, i_c, above which normal resistance reappears in the film. As soon as this happens the flux through the D's changes, a voltage signal is induced in the pick-up wire, and on removal of the drive pulse the element will have changed its state. The value of the critical current in the crossbar depends on its width and thickness, and on the temperature of the surrounding

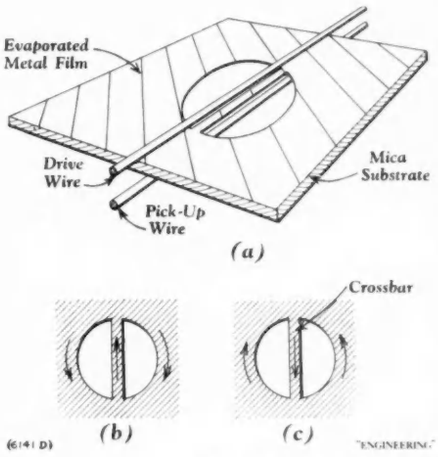
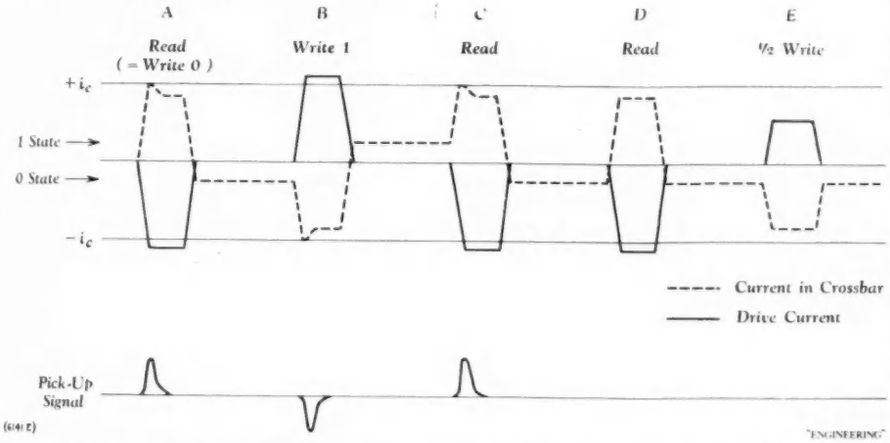


Fig. 4 The Crowe Element.

helium bath. Work on evaporated tin elements at the Royal Radar Establishment has shown that with a crossbar 0·2 mm wide and about 2,000 Å in thickness the critical current can be varied over a convenient range from zero to about $\frac{1}{2}$ ampere as the temperature of the helium bath is lowered from the transition temperature of tin, 3·7° K, to about 2° K. The length of the crossbar in this case was 2 mm.

The mode of operation of the element is shown in greater detail in Fig. 5, where the drive current, the crossbar current and the pick-up voltage are plotted against time for a typical series of drive pulses. First, a negative or "read" drive pulse (A) of sufficient amplitude to cause the induced crossbar current to reach its critical value, i_c, leaves a negative persistent current—i_p in the crossbar ("0" state). This current will, of course, flow indefinitely in the superconducting film until it is disturbed by a further drive pulse. A positive or "write 1" pulse (B) reverses the sequence of events and leaves a positive persistent current $+i_p$ in the crossbar ("1" state). Every time the state of the element is reversed a pick-up signal is induced on the leading edge of the drive pulse, so that on applying the "read" pulse (C) when the element is initially in the "1" state a signal is obtained. The "read" pulse (D), however, applied when the element is already in the "0" state, gives no signal, because throughout the pulse the crossbar current is less than $\pm i_c$, and on removal of the pulse the element remains in the "0" state. Finally, pulse (E) shows that, by suitable choice of amplitude, half-level pulses will not disturb the state of the element, so that coincident current working, using two drive wires for each element, can be used for selection of elements arranged in a square matrix. This is clearly a most important property if a really large computer store is to be constructed using these devices.

Fig. 5 Mode of operation of Crowe element.



The switching speed of the Crowe element is governed by two factors. In the first place the rate of decay of the current in the crossbar when the latter goes resistive depends on its normal resistance, R_n, and on the self-inductance, L, of the superconducting circuit. Typical values for elements of the size mentioned above are $R_n \sim 1/10$ ohm and $L \sim 10^{-9}$ henry so that $L/R_n \sim 10^{-8}$ sec. Secondly, as soon as the crossbar goes resistive heat is generated in it, and its temperature rises, thus decreasing momentarily the value of the critical current. The trailing edge of the drive pulse must clearly be delayed until the critical current has recovered at least very nearly to its full value, or in other words until the temperature of the crossbar has dropped to the bath temperature once more. This thermal recovery time depends on the substrate material, and experiments on tin elements at RRE[1], using a mica substrate and switching pulses 5×10^{-8} sec in length, have shown that in this case it is less than 3×10^{-8} sec. The amount of heat generated each time an element is switched is roughly Li_c^2 which, with $i_c \sim 300$ mA, is about 10^{-10} joule, and it is probably quite feasible to switch such an element at a frequency of 20 Mc/s, when the average power dissipation would still be only 2×10^{-3} watt. When such an element is switched with drive pulses of 200 mA amplitude, the voltage signals obtained are about 20 mV.

These superconducting memory elements thus satisfy all the necessary requirements for a really large and fast computer store, capable of a random access time of less than 10^{-7} sec for write-in and destructive read-out. This is more than 10 times as fast as existing ferrite core stores, but of course several formidable problems remain to be solved before such a store, containing perhaps 10 million elements, can be successfully constructed.

In the first place the store itself has to be immersed in a liquid helium bath, and to obtain random access to this number of "bits," dividing them into "words" and "digits" in the usual way, will require roughly 10^3 selection circuits, even making use of coincident current drive wires. This is far too large a number to be brought from the helium bath up to room temperature, on account of the excessively large heat influx which would result, and so it will clearly be necessary to develop selection circuits which can themselves operate entirely in the liquid helium. Provided this can be done the number of separate wires brought up to the "outside world" need be no more than about one thousand, which is not excessive. It is possible that the low avalanche field of certain semiconductors at very low temperatures could be utilised to provide such selection devices.

The elements themselves with their associated drive and pick-up circuits are certainly compact enough to allow a large store to be assembled in a reasonable space. 10 million "bits" need occupy little more than a cubic foot. Much work needs to be done, however, to ensure that the properties of the individual elements are sufficiently uniform, and this needs very careful control of the evaporation process. Furthermore the associated circuitry must be capable of transmitting very short pulses without distortion, in order to make full use of the inherently high speed of the elements. Luckily the planar form of the elements lends itself to an arrangement of drive and pick-up wires as strip transmission lines, which should be ideal for this purpose.

Finally, the low temperature requirements of the store would probably best be met by the use of a small built-in helium liquefier of the closed circuit type, designed so that on starting up the machine the correct working temperature would automatically be maintained. The liquefaction rate need not be high, since the total power dissipation even in a store of the size considered, working at 20 Mc/s, and assuming that 100 elements are switched at once on the average, will only be about 0·2 watt; the additional heat dissipation due to conduction down leads might perhaps increase this figure to 1 watt, so that possibly 2 litres per hour of liquid helium would be required during operation. This will not present a serious engineering problem.

It is worth noting that this type of store may be capable of working within a factor of ten or so of the maximum possible speed of random access, set by the ultimate limitation of the velocity of light. Assuming that any store of reasonable size will require access lines of the order of a foot in length, then the access time must correspondingly be of the order of a millimicrosecond or so. Since it is possible that the superconducting store may achieve a random access time of 20 millimicroseconds, it may well come within striking distance at least of this ultimate goal.

References

[1] Buck, D. A., "The Cryotron," 482-493, *Proc. IRE*, vol 44, 1956, USA.

[2] Crowe, J. W., "Trapped Flux Superconducting Memory," 294-303, *IBM Journal of Research and Development*, vol. 4, Oct. 1957, USA.

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

LONDON
"Electronic Equipment of Airfields," by E. H. Bruce-Clayton. London National Lecture. Institution of Electrical Engineers, Savoy Place, Victoria Embankment, WC2. Tues., 28 April, 6.30 p.m.*

BRISTOL
"Plastics in the Electrical Industry," by A. Walters. Bristol and West of England Branch. Grand Hotel, Bristol. Fri., 1 May, 8 p.m.

HOVE
"Power Factor Correction," by J. W. Fletcher. Brighton, Hove and District Branch. New Imperial Hotel, First Avenue, Hove. Thurs., 30 April, 7.30 p.m.

British Institution of Radio Engineers

LONDON
Two papers on "Electron Microphony," by Professor G. Causey and R. S. Page. Medical Electronics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Tues., 28 April, 6.30 p.m.*

CHELTENHAM
"Transistor Amplifiers," by F. Butler. South Midlands Section. North Gloucestershire Technical College, Cheltenham. Fri., 1 May, 7 p.m.

British Interplanetary Society

LONDON
"Inertial Guidance and Its Application to Astronautics," by D. J. Cashmore. Caxton Hall, off Victoria Street, SW1. Sat., 2 May, 6 p.m.

Building Centre

LONDON
Film "Rolled Zinc in Architecture," exhibited by the Zinc Development Association. Wed., 29 April, 12.45 p.m.

Chemical Society

BIRMINGHAM
"The Structure and Reactivity of Reduced Metallic Surfaces," by Professor K. W. Sykes. Birmingham Branch. Chemistry Department, The University, Birmingham. Fri., 1 May, 4.30 p.m.

CARDIFF
Various papers for discussion. South Wales Branch. Chemistry Department, University College, Cardiff. Mon., 27 April, 7 p.m.

ST. ANDREWS
"Chemical Effects Due to Fission Fragments," by Dr. R. Spence. St. Andrews and Dundee Branch. St. Salvator's College, St. Andrews. Fri., 1 May, 5.15 p.m.

Combustion Engineering Association

LONDON
"Economic Purchase of Coal for Small Plants," by Dr. G. Armstrong. Southern Region. St. Ermin's Hotel, Caxton Street, Victoria Street, SW1. Thurs., 30 April, 10.30 a.m.

PORTHCAWL
Brains Trust on "The Working of the Clean Air Act," at 11 a.m.* "Structural Insulation," by P. E. Millington, at 2.15 p.m. Western Region. Seabank Hotel, Porthcawl, Glam. Tues., 28 April.

Faraday Society

LONDON
Bourke Lectures: "Surface Diffusion," by Dr. Robert Gomer (of the University of Chicago). Physical Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, SW7. Mon., 4 May, 4.30 p.m.

Helicopter Association

LONDON
"Helicopter Noise Suppression," by H. B. Irving. Royal Aeronautical Society, 4 Hamilton Place, W1. Fri., 8 May, 6 p.m.

Illuminating Engineering Society

CARDIFF
Open discussion meeting on lighting subjects. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., 7 May, 6 p.m.

Institute of Marine Engineers

BRISTOL
Films: "Engineering at Calder Hall," "Criticality "and "Radioisotopes in Industry." West of England Section. Grand Hotel, Bristol. Mon., 27 April, 7.30 p.m.

Institute of Metals and Iron and Steel Institute

LONDON
A series of papers on "Theoretical Aspects of Sintering." Powder Metallurgy Joint Group all-day meeting. Church House, Great Smith Street, Westminster, SW1. Wed., 29 April, 9.30 a.m. (Postponed from 12 March: tickets not required.) Evening Conversazione at 17 Belgrave Square, SW1. Wed., 29 April. (Restricted to members of the two Institutes and their guests: tickets are required for this function.)

Institute of Metals

SHEFFIELD
Chairman's Address, by Professor R. W. K. Honeycombe. Sheffield Local Section. Engineering Lecture Theatre, The University, St. George's Square, Sheffield. Thurs., 30 April, 7.30 p.m.

Institute of Petroleum

LONDON
Symposium on "Submarine Exploration for Oil," conducted by members of BP Exploration Co., Ltd. Wed., 6 May, 5.30 p.m.*

Institute of Refrigeration

LONDON
"The Handling of Cryogenic Liquids for Rocket Engines," by D. Hurden. Institute of Marine Engineers, Memorial Building, 76 Mark Lane, EC3. Thurs., 7 May, 5.30 p.m.*

Institution of Chemical Engineers

LONDON
Annual General Meeting, at 10.45 a.m. Annual Dinner, at 7 for 7.30 p.m. Park Lane Hotel, Piccadilly, W1. Tues., 28 April.

Institution of Civil Engineers

LONDON
"A Project for Extending the Nigerian Railway into Bornu Province," by Sir Ralf Emerson. Tues., 28 April, 5.30 p.m.*

CHESTER
Annual Branch Meeting. North Western Association. Queen Hotel, Chester. Thurs., 30 April, 7.30 p.m.

Institution of Electrical Engineers and British Nuclear Energy Conference

LONDON
Convention on "Thermonuclear Processes," at Institution of Electrical Engineers, Savoy Place, Victoria Embankment, WC2. Wed., 29 April; and Thurs., 30 April; at 10 a.m.

Institution of Electrical Engineers

LONDON
"Field Strengths Required for the Reception of Television in Bands I, III, IV and V," by G. F. Swann. Radio and Telecommunication Section. Mon., 27 April, 5.30 p.m.*
Discussion on "Microwave Radiation Hazards." Medical Electronics Discussion Group. Fri., 8 May, 6 p.m.*
Annual General Meeting and Film Display. London Graduate and Student Section. Wed., 6 May, 6.30 p.m.*

BELFAST
Annual General Meeting. Northern Ireland Centre. David Keir Building, Queen's University, Stranmillis Road, Belfast. Tues., 5 May, 6.30 p.m.

EDINBURGH
Annual General Meeting. South East Scotland Subcentre. Carlton Hotel, North Bridge, Edinburgh. Tues., 5 May, 7 p.m.

LEEDS
Annual General Meeting. North Midland Centre. Offices of the Central Electricity Generating Board, Leeds. Tues., 5 May, 6.30 p.m.

MANCHESTER
Annual General Meeting. "Electrical Supplies to Power Station Auxiliaries," by D. A. Dewison. North Western Centre. Engineers' Club, Albert Square, Manchester 2. Tues., 5 May, 6.15 p.m.*

WEYMOUTH
Open Meeting. Southern Centre. South Dorset Technical College, Weymouth. Fri., 1 May, 6.30 p.m.*

Institution of Electronics

LONDON
"Measurements in Aviation Physiology," by G. H. Byford. London Division. University of London Institute of Education, Malet Street, WC1. Thurs., 30 April, 7 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
Annual General Meeting. "Applications and Limitations of Packaged Boilers," by A. Wilson. Scottish Branch. Building Centre, 425 Sauchiehall Street, Glasgow, C.2. Tues., 28 April, 7 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "Extended University Courses for the Better Graduate." Education Group. Tues., 28 April, 6 p.m.*
Discussion on "Industrial Finishing." Industrial Administration and Engineering Production Group. Wed., 29 April, 6 p.m.*

Institution of Production Engineers

LONDON
1959 George Bray Memorial Lecture on "The Search for Productivity in a Food Industry," by Mark Bogod. Royal Commonwealth Society, Northumberland Avenue, WC2. Wed., 29 April, 6.30 p.m.

MANCHESTER
"Productivity in the Cotton Textile Industry," by Allan Ormerod. North Western Region. Manchester College of Science and Technology, Manchester. Mon., 27 April, 7 p.m.

Institution of Public Health Engineers

HARROGATE
Royal Sanitary Health Congress. "The Treatment of Strong Organic Wastes by Anaerobic Digestion," by A. E. J. Pettet, J. G. Tomlinson and J. Hemens. Hotel Majestic, Harrogate. Mon., 27 April, 5.30 p.m.

Institution of Railway Signal Engineers

BRISTOL
Annual General Meeting. "Modern Trends in the Design of Signalling Apparatus," by E. J. Harris. Bristol Centre. Bristol Temple Meads Station, Bristol. Mon., 27 April, 6 p.m.*

Institution of Structural Engineers

BIRMINGHAM
"Future Trends in Structural Engineering," by Professor S. C. Redshaw. Midland Counties Branch. Department of Civil Engineering, The University, Birmingham. Fri., 8 May, 10 a.m.

Junior Institution of Engineers

LONDON
"A Peep Behind the Iron Curtain," illustrated, by G. V. Rickards. Fri., 1 May, 7 p.m.*

Leeds Metallurgical Society

LEEDS
Annual General Meeting. "Electric Melting Furnaces," by F. S. Leigh. Chemistry Wing, The University, Leeds 2. Thurs., 7 May, 7.15 p.m.

Physical Society

LONDON
"The Handling of Cryogenic Liquids for Rocket Engines," by D. Hurden. Low Temperature Group. Institute of Marine Engineers, Memorial Building, 76 Mark Lane, EC3. Thurs., 7 May, 5.30 p.m.*

Reinforced Concrete Association

BRISTOL
"Precasting in Concrete Framed Construction," by J. F. Greining and R. Westbrook. West of England Branch, New School of Engineering, The University, Bristol. Thurs., 30 April, 6 p.m.*

Royal Aeronautical Society

LONDON
Discussion on "The Electronics of Guilded Missiles." Institution of Civil Engineers, Great George Street, SW1. Mon., 27 April, 6. p.m.*

Royal Institution

LONDON
"The Antarctic," by G. de Q. Robin. Wed., 29 April, 9 p.m.

Royal Society

LONDON
Various short papers for discussion. Thurs., 30 April, 4.30 p.m.*

Royal Statistical Society

SHEFFIELD
Annual General Meeting. "A General Simulation Programme," by Dr. K. D. Tocher. Sheffield Industrial Applications Group. Grand Hotel, Sheffield. Thurs., 30 April, 7 p.m.

Society of Chemical Industry

LONDON
Annual General Meeting and Chairman's Address by S. G. Clarke. Corrosion Group. Wed., 6 May, 6.30 p.m.

Society of Engineers

LONDON
"Grouting and Civil Engineering," by D. J. Ayres. Geological Society, Burlington House, Piccadilly, W1. Mon., 4 May, 5.30 p.m.*

Society of Instrument Technology

LONDON
"Measurements in the Photographic Industry," by M. E. F. Howarth and P. B. Watt. Manson House, Portland Place, W1. Tues., 28 April, 6 p.m.*

CHESTER
Annual General Meeting and Film Evening. Chester Section. Grosvenor Museum, Grosvenor Street, Chester. Wed., 29 April, 7 p.m.

Southampton Metallurgical Society

SOUTHAMPTON
Annual General Meeting, followed by a social function. Small Physics Lecture Theatre, The University, Southampton. Thurs., 7 May, 7.15 p.m.

Television Society

LONDON
Annual General Meeting. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, WC2. Fri., 8 May, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough Gardens, London, SW1. (TATe Gallery 9371.)
British Nuclear Energy Conference, Great George Street, London, SW1. (WHItehall 4577.)
Building Centre, 26 Store Street, London, WC1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, SW1. (WHItehall 5536.)
Faraday Society, 6 Gray's Inn Square, London, WC1. (CHAncery 8101.)
Helicopter Association of Great Britain, 4 The Sanctuary, London, SW1. (ABBey 5160.)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493.)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291.)
Institute of Petroleum, 61 New Cavendish Street, London, W1. (Langham 3583.)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London, EC4. (CENtral 4694.)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647.)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (TEMple Bar 7676.)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield Street, London, W.1. (GROsvenor 5254.)
Institution of Public Health Engineers, c/o The Portman Building Society, 39 Portman Square, London, W1.
Institution of Railway Signal Engineers. Apply to Mr. R. L. Weedon, 222 Marylebone Road, London, NW1. (AMBassador 7711.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128.)
Iron and Steel Institute, 4 Grosvenor Gardens, London, SW1. (SLOane 0061.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786.)
Leeds Metallurgical Society. Apply to Dr. P. Feltham, The University, Leeds.
Physical Society, 1 Lowther Gardens, South Kensington, London, SW7. (KENsington 0048.)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335.)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638.)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681.)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244.)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251.)
Southampton Metallurgical Society. Apply to Mr. S. W. Hallwood, Folland Aircraft Ltd., King's Avenue, Hamble, Hants.
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330.)

On the Shelf

By Frank H. Smith

From *Soviet News* (13 March) we learn that the USSR Academy of Sciences (there's no getting away from the body) has set up a national committee on automatic controls. It will hold what is described as the first international congress on automatic controls in Moscow, 25 June to 5 July next year. Three hundred papers will be submitted. Russian librarians have their troubles too. In the 16 March issue we learn that the Foreign Languages Publishing House contemplates quite a number of books by English authors, including Maugham's *Of Human Bondage*. Eight out of ten for unconscious humour.

It is more or less an accepted fact (and therefore probably no longer true) that American firms make the results of their researches known with greater freedom than their English counterparts. Take, for instance, the Cook Electric Company of 2700 Southport Avenue, Chicago 14, Ill. Every now and again they produce a *Technical Review*, the latest of which, Volume 5 Number 1 of December, 1958, is entitled "Analytical Techniques for Systems Studies" by Bellamy, Clark and Bohan. Fourteen pages, 14 figures, at a dollar the lot.

British Standard 350, Part 1, is entitled "Conversion factors and tables (basis of tables; conversion factors)." It costs 15*s* and there is not much more I need say. But I will point out that this is only Part 1 and runs to 114 pages. "In the meantime (i.e. awaiting Part 2 with detailed tables) the detailed tables of the 1944 edition will still be serviceable and are obtainable at the reduced price of 7*s* 6*d*." Those of you who have the 1944 should have a corrigendum to stick in.

Aluminium News, the little bulletin issued in the interests of the companies associated with Aluminium Limited (Box 6090, Montreal) is quite an unpretentious affair of about eight pages each month but I'll say this for it—it does produce an index, which is more than can be said for a high percentage of reputable journals on the other side of the ditch.

The Oxford Dictionary folk have published their third list of words for which they want earlier references. Now that they're up among the B's it's getting a bit more exciting ("B" as in blood group, to "breath-group" as in phonetics). Nice words like belly-flop (any advance—or retreat—on 1947?) and bastard "in trivial use." What's trivial use for Pete's sake? I rather like battle-axe (termagant) but I am sure somebody will come up with an earlier reference than 1952. If you want to help, write to The Editor, Oxford English Dictionary Supplement, 40 Walton Crescent, Oxford.

Those Americans are at it again. *American Aviation*, which has contrived to get by on that name since about 1937, will be *Airlift* from April. Wayne Parrish—one of the best known names in American aeronautical journalism—tells us in his editorial that *Airlift* simply means "transportation by air." So what? I think he's being rather disloyal to a title that has given itself to the whole publication business that Parrish runs—American Aviation Publications Inc. *And* it's damned silly to change the title quarter way through a year. That is what really irks me as a librarian.

A bundle of interesting papers from the Society of Technical Writers and Editors Inc. (P.O. Box 3706, Beechwold Station, Columbus 14) includes a "Bibliography of Technical Writing, 1945-1957." I *think* it is gratis.

I suppose the British Interplanetary Society can afford to be a bit cock-a-hoop now and this sentiment is exemplified by their expansion from a humble grey 9 by 6 journal to a bright blue 11 by 8 effort. And the best of luck to them. They've been scoffed at for years and gone steadily ahead with really scientific and erudite papers. I expect the *Flying Saucer Review* is only awaiting its chance to say "I told you so."

HIGH VACUUM

Fourth National Symposium on Vacuum Technology: Transactions. Edited by WILFRED G. MATHESON. *Pergamon Press, 4 and 5 Fitzroy Square, London, W1.* (90*s*)

The impetus given by the atomic energy programme and its associated projects has led in recent years to notable advances in the field of industrial high vacuum. A branch of engineering which hardly existed 15 years ago is continually finding wider application. The increasing interest in vacuum techniques is indicated by the fact that the attendance (about 600) at the Fourth National Symposium on Vacuum Techniques, held at Boston, Massachusetts, in October, 1957, and sponsored by the American Vacuum Society, was almost double that at the first symposium held in 1954. This volume contains the complete proceedings of the symposium. Twenty-eight papers were presented, the majority of them by American authors.

It is now generally recognised that sorption phenomena play an important role in both the production and the measurement of high vacua. The attainment of pressures of 10^{-4} mm Hg and below in demountable systems is largely dependent upon the removal of molecules which are adsorbed on the surfaces inside the vacuum system, these molecules being mainly water vapour and organic hydrocarbon vapours from gaskets and possibly from the diffusion-pump oil. Further reduction in pressure, say below 10^{-8} mm Hg, may involve the removal of chemisorbed gas molecules such as oxygen, carbon dioxide, nitrogen and others. Current developments in ultra high vacuum techniques therefore require greater knowledge concerning surface phenomena. On the other hand, high vacuum techniques make it possible to exploit fruitful methods of research into the physics and chemistry of surfaces. One such approach is the investigation of the apparently anomalous properties of evaporated metal films—these include unusually high resistivities, low or negative temperature coefficients of resistance and unexpected optical characteristics. Such films have also been widely used in studies of adsorption and surface reactions.

All these aspects are touched upon by contributions in the first, the largest of three sections in the volume under the general heading "Scientific Basis of Vacuum Techniques—Applications to Scientific and Applied Research." Other developments also mentioned include fundamental studies aimed at elucidating the mode of operation of high vacuum pumps with the object of improving their performance.

In the second section ("Methods and Techniques for Obtaining and Measuring High Vacuum—Industrial Applications") the subjects discussed range over the use of getter-ion pumps and steam jet ejectors for producing high vacua, the problems encountered in large-scale metallising processes, and the vacuum drying, degassing and impregnation of paper-insulated electrical components on a commercial scale. This latter process has been extensively developed in Germany over the last two years, much of the work being based on American experience on high vacuum distillation techniques. It is shown how the vacuum process can be evaluated, both technically and economically, to produce for given materials the particular final condition which is required (in terms of dielectric properties). In the process of vacuum metallising one of the most commonly used metals, aluminium, poses problems because of its extreme reactivity with the container vessel at the temperatures required for efficient evaporation (namely above 1,200 C) and some of the methods used in an attempt to overcome this disadvantage are discussed. The performance characteristics (but not detailed design), installation, operational and maintenance costs of steam jet ejectors are discussed in some detail. This type of pump is becoming increasingly used in the vacuum metallurgy industry in the United States, where relatively large pumping capacity is required, as for example, in steel mills and foundries. With multistage units (typically, six stages) operating pressures of less than 10 microns (10^{-2} mm Hg) and pumping speeds in excess of 250,000 cu. ft per min are possible. It is claimed that the maintenance costs on steam jet ejectors are relatively low even for "dirty" processes when contamination, either in the form of particulate matter (dirt and metallic particles, for example) or corrosive gases, is inevitable. Their main disadvantage is the possibility of water vapour back-diffusing into the system but this can be prevented by suitably adjusting the operating conditions.

Much progress has been made since the original application of vacuum heat treatment to the purification of titanium and in the last section ("Industrial Applications") the evolution of commercial vacuum furnaces is briefly reviewed, as well as the basic principles involved in the main vacuum heat treatment processes—induction melting, arc melting and stream degassing. Briefly, induction melting is used for the production of relatively small amounts of material where composition control is essential. In vacuum arc remelting, gaseous concentrations in the metal (oxygen, nitrogen, hydrogen) are greatly reduced, as a result of which metals such as molybdenum, niobium and vanadium become workable. Stream degassing, also known as vacuum casting, is used mainly to reduce the hydrogen content of steel. This refinement is brought about when the molten metal is released, by pouring, into a vacuum chamber evacuated to a pressure of 1 mm Hg or below. Large quantities of gas are released—a typical figure being of the order of 10,000 cu. ft per ton of metal. The stream degassing process is of some significance economically in that it enables tonnage quantities of steel (up to 250 tons) to be refined in a single heat.

It has only been possible to indicate briefly the diversity of subjects covered by the symposium. The presentation of the present volume follows closely that of the three preceding volumes and it provides with them a useful source of information on many aspects of high vacuum engineering and also on current industrial application of vacuum techniques, more especially in the United States. A minor lapse has resulted in Fig. 1 on page 6 being printed upside down, but otherwise the photographs and diagrams are numerous and well produced.

MATERIALS TESTING

Handbuch der Werkstoffprüfung. Vol. I:- Prüf- und Messeinrichtungen (Handbook of Materials Testing. Vol. I: Qualitative and Quantitative Instrumentation). By E. SIEBEL and N. LUDWIG. Berlin 1958. *Springer-Verlag (Heidelberger Platz 3, Berlin-Wilmersdorf, Germany)* (148·50 *DM*)

This is a completely revised edition of the 1939 edition and deals with the practical aspect of methods and appliances for material testing in general. The complete handbook now comprises five volumes. Four of these are available in second revised editions; the fifth and new volume is about to be published.

Professor Dr.-Ing. E. Siebel, the general editor, is director of the Government institute for materials testing at the Technical University of Stuttgart; his collaborator in the present volume is in charge of the German standards committee for materials testing. The various sections are written by 23 experts in the different fields. The second edition of the first volume is enlarged by the inclusion of metallography as well as chemical and spectrochemical testing. These were formerly parts of the second volume.

Added, too, are chapters on ultrasonic and inductive (vortex-current) testing.

Treated in this volume are: the standard constant-load testing appliances (for tension, compression, bending, reversal bending, shear, torsion and hardness); shock-loading machines; a brief historical survey on the testing of materials (giving due credit to British work), and specialised instrumentation for qualitative determinations. Some 90 pages are devoted to vibration testing, with no mention of the subject " Ermüdung " (fatigue) given in the index, and it appears that modern work in this most important subject is not adequately taken into account. Fully treated are: hardness testing; the checking and evaluation of testing machines in general; the measurement of deformations (including strain-gauge and brittle-lacquer practice); photoelasticity; strain determination by X-rays; gamma-ray investigations (with betatrons and isotopes); magnetic-flux testing methods; metallography including electron and emission microscopy; methods for determining changes of state, and other topics. Since a handbook of this kind is generally used for reference, the separation of names and subject in two indexes is unsatisfactory.

This carefully edited and fully authoritative handbook is written for the practical engineer, and theory is kept to a minimum.

COMBUSTION RESIDUES

Schlakenkunde (Textbook on Furnace Slags). By WILHELM GUMZ, HELMUT KIRSCH and MARIE-THERESE MACKOWSKY. Berlin 1958. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* 422 pp. with 167 Figs., two-colour table, appendices, glossary, name and subject indices. (*DM* 48)

This is a comprehensive and timely textbook on all forms of furnace or combustion chamber wastes such as ashes, slags, external-boiler or fire-grate deposits and all sorts of dusts shed by chimneys, funnels and stacks. The approach is typically German: very thorough, with full consideration of all aspects; the subject matter is sifted with very fine sieves indeed—in both senses. The three authors are research workers in the Ruhr coal industry; Professor Mackowsky is a university lecturer in addition.

The chapters consider coal, coal minerals and lignite; the ashes left by solid fuels; the methods for investigating them mineralogically and technologically; the behaviour of coal minerals when heated; the constitution of slags and external boiler deposits, in terms of their chemistry, mineralogy and petrography; the representation and evaluation of experimental results; the theory of deposit formation; the discussion of measures for the prevention of slag-clogging (clinkering) and of deposits on heating surfaces, from the combustion of coal, coal dust, lignite and oils (including a consideration of gas-turbine problems); and the uses of combustion wastes.

One appendix refers to details of chemical investigation methods giving particulars for complete waste analyses, including those for rapid determinations. A second appendix is a welcome glossary of technical and mineralogical terms. This provision does, of course, widen the scope of the book because it renders it even more understandable for the average engineer. The book is not only of interest to the combustion or clean-air specialist or for the mineralogist, but also to those who deal with ceramics for heat-resisting or building purposes, for designers of gas turbines, and so on. It is written with admirable clearness, considers the international work in the field, and quotes all available literature in related domains. Adequate consideration is given to British research.

BUILT TO HANDLE SHIPS

Introduction to Dock and Harbour Engineering. By ROLT HAMMOND. *Thomas Nelson and Sons Limited, Parkside Works, Edinburgh, 9.* (25*s*)

" This book deals with all aspects of dock and harbour design and the problems which confront engineers, dock and port authorities, and everyone concerned with the organisation of marine trade." So claims a statement on the book cover. It is no discredit to Mr. Rolt Hammond that he has not accomplished this impossible task in the 155 pages of his *Introduction to Dock and Harbour Engineering*, for docks and harbours are complex organisations calling for a wide range of civil, mechanical and electrical skills in their construction and maintenance as well as an extensive specialised knowledge in purely maritime structures. An introduction to this vast subject can at best only be an attempt to indicate some of the many problems involved and how they are tackled and Mr. Hammond's effort to do this is only partially successful.

The volume is one of Nelson's Nautics, " a series of monographs designed to give those who are concerned with shipping in any of its aspects a full factual survey of the way in which ships operate," according to a preface by the general editor. One assumes, therefore, that the volume is to be read by non-engineers, yet the book is besprinkled with terms such as " cusecs," " normal pressure," " berms," " unconfined compressive strength " and so on, which a layman must find unintelligible, and what is he to make of such a phrase as " the storm waves change from waves of oscillation to waves of translation "?

An obvious difficulty facing the author of a work of this nature is one of selection. In his book Mr. Hammond displays an unfortunate lack of balance. In several pages describing diving dress he goes into considerable detail—" Care must be taken in storing dresses. First they should be cleaned by scrubbing with soapy water . . .," yet diving bells receive scanty mention and such an important subject as steel sheet piling only a passing reference. Perhaps the author has deemed it advisable to concentrate on subjects more obviously attractive to the uninitiated and indeed in a chapter entitled " The Harbour Engineer in War," the description of the organisation and construction of Mulberry Harbour cannot fail to hold the interest of engineer and layman alike. Other subjects excellently dealt with are transport facilities in and to ports and speeding the turnround of ships. Chapters are included on oil handling in ports, mechanical handling, dock cranes and dredging. (The author uses the American " dredge " rather than " dredger " more normal in English usage—and familiarity with American practice rather than British appears to be evidenced in the chapter on " Planning the Harbour ").

The book contains an index, which is not, however, very comprehensive. References are given in the form of footnotes but the author indulges in the irritating habit of making such remarks as " Tooth has summarised the main factors affecting rate of discharge . . ." without giving any reference or indicating who Mr. Tooth is. Experienced maritime engineers and operators will be acquainted with Mr. Tooth's contributions to mechanical handling studies, but most of those seeking to be introduced by Mr. Hammond to dock and harbour engineering can hardly be expected to be so and must suffer some frustration at this inexplicable assumption that they are.

Mr. Hammond's book is useful but it cannot be said to fulfil the need of a brief but well constructed and coherent introduction to maritime engineering.

NEW BOOKS

The Running and Maintenance of the Marine Diesel Engine. By JOHN LAMB. Sixth Edition, Rewritten. *Charles Griffin and Company Limited, 42 Drury Lane, London, WC2.* (58*s*)

The revision of this well known " working tool " for ships' engine-room staff was completed by the late Mr. John Lamb shortly before his death. It was first published in 1920; and the previous edition, published in 1939, ran to seven impressions.

Linear Programming Methods and Applications. By SAUL I. GASS. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA;* and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (50*s* 6*d*)

" Programming problems are concerned with the efficient use or allocation of limited resources to meet desired objectives," a linear programming problem is one which can be stated by a mathematical model or description. This textbook introduces the method in a manner suitable for students of first year degree courses in mathematics. The material has been presented in three parts: introductory, methods—both theoretical and computational—and applications.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Components

Locknuts. WHITEHOUSE INDUSTRIES LTD., Ferrybridge, Knottingley, Yorks. " Philidas " self-locking nuts. Range includes B.A., B.S.W., B.S.F., U.N.C., and U.N.F. series in brass, stainless steel, mild steel, or light alloy. Catalogue.

Mechanical Seals. CRANE PACKING LTD., Slough, Bucks. Catalogue and reference book of mechanical seals for most fluids; nearly 300 chemicals listed with the appropriate seal material. Charts of sizes, power losses, temperature and pressure, included.

High Capacity Bearings. POLLARD BEARING CO. LTD., Ferrybridge, Knottingley, Yorks. " Max-Load " high capacity roller bearings; loadings up to 175,000 lb. Brochure includes selection chart as well as dimensions and also tables of equivalent American sizes.

Bellows Joints. SAMSON CONTROLS LTD., 19 Borough High Street, London, SE1. Metal bellows expansion joints made from seamless drawn copper-bronze alloy. Range of sizes. Leaflet.

Cam Followers. INSLEY (LONDON) LTD., 21-22 Poland Street, London, W1. " Nadella " needle and roller bearings for use in cam follower assemblies. Sizes from 7·3 mm bore upwards. Leaflet.

Bearing Equivalents. POLLARD BEARINGS LTD. Ferrybridge, Knottingley, Yorks. Interchangeability tables of bearings in tractors and farm equipment generally. All American makes are included with their reference numbers and Pollard equivalent. Ref. It3/8/58. Also tables for clutch and fan and water pump bearings for American vehicles and tractors. Ref. CWFPS/IT/3/58.

Clutches. RENOLD CHAINS LTD., Renold House, Wythenshaw, Manchester. " Sprag " clutches for all duties. Capacities 50 lb-in to 136,000 lb-ft. Catalogue with tables and installation notes.

Palnuts. THE PALNUT CO. LTD., Palnut Works, Arthur Street, Hove, 3. Palnuts for locking against vibration. Leaflet gives examples of use on tank wagons.

Remote Control Valves. ROTORK ENGINEERING CO. LTD., Widcombe Manor, Bath. Electrical actuator for the remote control of pipeline valves. Range for all sizes of steam, gas, or liquid systems. Booklet.

Industrial Hose. BTR INDUSTRIES LTD., Herga House, Vincent Square, London, SW1. Industrial hose of rubber or thermoplastics materials; all sizes up to 18 in internal diameter. Fabric or wire reinforced; bursting pressures up to about 3,000 lb per sq. in. Illustrated catalogue.

Stoneware. DOULTON INDUSTRIAL PORCELAINS LTD., Wilnecote Works, near Tamworth, Staffs. Chemical and industrial stoneware containers and plant; tanks, cocks, pipelines, towers, filters, etc. Illustrated catalogue.

Springs. COCKBURNS (SPRINGS) LTD., Meiklewood Road, Cardonald, Glasgow, SW1. Springs of all forms and most materials. Folder.

MATERIALS

At the Olympia Exhibition

Continued from page 504, 17 April

At the time of publication of this issue, the Engineering, Marine, Welding and Nuclear Exhibition is entering the second half of its 15 day stay at Olympia. In last week's issue details were given of some of the new materials and their applications as featured at the exhibition. Here are more—representative of all the branches of engineering denoted by the exhibition's title.

FREE CUTTING AND FINE GRAIN

When high-speed automatic lathes are used with conventional aluminium alloys, long helices of swarf are formed. To overcome this, new free cutting alloys have been developed, to which range, ICI Metals Division, Kynoch Works, Birmingham 6, have contributed 11S—a medium-strength heat-treatable alloy which may be machined at speeds which are limited only by the maximum spindle speed available. Kynal 11S is the British equivalent of an alloy containing lead and bismuth with chip-breaking particles,

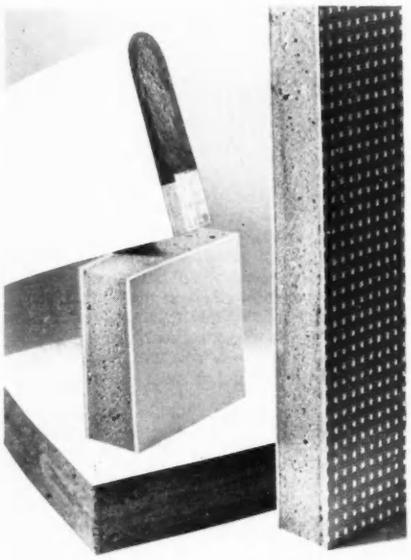


Fig. 2 (left) Urethane foams bonded to plywood, sheet metal or laminated plastics provide sound and heat insulating panels

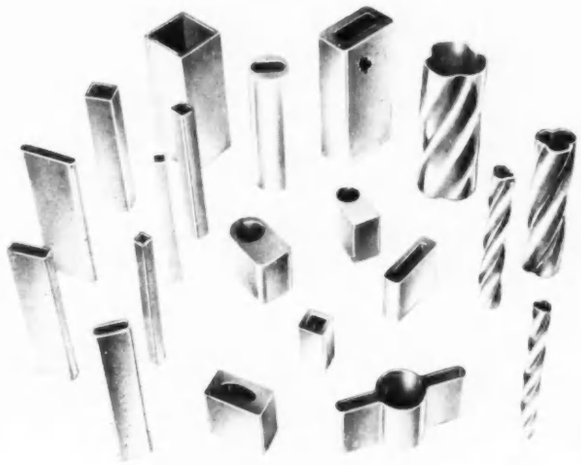


Fig. 3 (right) Even the most unusual copper sections can normally be provided in lengths of more than 20 ft.

which has already proved itself in the United States.

The alloy is supplied in rounds to Class A tolerances in $\frac{6}{16}$ to $\frac{1}{2}$ in diameters in lengths from 12 to 18 ft, and in $\frac{1}{2}$ to $1\frac{1}{2}$ in diameters in lengths up to 20 ft. A typical value of 0·1 per cent proof stress is 19·5 tons per sq. in, with an elongation of 12 per cent on 2 in. Certain machining operations can be carried out dry, but a cutting fluid such as soluble oil, lard oil or a mixture of equal parts of lard oil and paraffin is recommended where good surface finish is required, and for high-speed work.

Elimination of the tendency to form peripheral coarse grains in magnesium-aluminium sections is the object of the development of a new technique in extrusion by the same division of ICI. This technique has met with some success and although details are not presently available, the company hope to extend the process to sections other than rounds, producing extrusions with uniform amounts of residual work in all parts of the section, which therefore recrystallise during heat treatment to give a uniform small grain size.

In copper, development of the Kuniform range of fine-grain copper alloy strip should facilitate polishing and reducing labour costs in finishing processes. Kuniform strip is slightly less ductile than deep drawing quality brass, but is suitable for any but the deepest single-stage pressings or those requiring inter-stage annealing. Such a fine grain strip is also made in a range of copper zinc alloys from 64/36 to 90/10.

RESISTANT COATING

In 1844, Wurtz published the first reference to the reduction of nickel by hypophosphite ions; he reported that metallic nickel was deposited when a solution of nickel hypophosphite was evaporated at 95° C. It was not until a century later that subsequent work resulted in an industrial economical process known as Kanigen plating, for which Albright and Wilson, 1 Knightsbridge Green, London, SW1, are licencees in four countries including the United Kingdom.

As an example of the use of this process in nuclear engineering, the company are exhibiting a master slave manipulator made by Savage and Parsons which has hand and tong head assemblies made from aluminium and stainless steel coated with Kanigen. In the nuclear field, the coatings are used extensively to combat corrosion caused by uranium hexafluoride.

Kanigen, as is generally known, is a nickel-phosphorus alloy containing about 8 per cent phosphorus, which is deposited from a non-electrolytic chemical bath. All surfaces of a component, however complex in shape, are coated if the solution can circulate past them.

Porosity of the coatings is low, and with a hardness as deposited of 500 VPN, or after heat treatment at 400° C of 1,000 VPN, the coatings provide good chemical and abrasion resistance. Kanigen may be applied to non-metals such as thermo-setting plastics, ceramics and glass if the surfaces are specially prepared, to give a coating which is continuous and adherent, but which usually has a satin finish.

TREATMENT BEFORE PAINTING

The Plus-Gas Company Limited, 1-11 Hay Hill, London, W1, have added to their range of products a new Formula E external metal treatment, described as a new tannating process for the pretreatment of surfaces prior to painting.

This preparation combines with oxides to form an insoluble film which will stand up to weathering for several days. Inside buildings under normal conditions it will, of course, last much longer. The tannin produces a surface which bonds well with paints and cannot chip or flake. It can considerably prolong the life of ordinary paint on steel or iron by preventing the formation of rust beneath it.

Formula E, the makers say, is a non-acid and harmless chemical, which can be used not only on metal surfaces already rusted or corroded, but also on painted surfaces even if the coating is partially or completely broken down.

Fig. 1 This tube of Sintox has been forced under a 20 ton load through ¼ in steel plate.

ALUMINA CERAMIC

Sintox is no longer a newcomer into the world but a thriving youngster. Harder than glass, with an ultimate tensile strength of 18,300 lb per sq. in, it has many other desirable properties. Further to the standard 95 per cent alumina grades FA1 and FC1, the makers, Lodge Plugs, Limited, Rugby, have added grade FF1, intended as a modification of the standard versions with the low neutron capture cross-section of 508 mbs per mol.

Sintox is a non-porous ceramic sintered at high temperature, and components of it are usually made to a dimensional tolerance of ± 2 per cent or 0·008 in, whichever is the greater, although facilities now exist for grinding to lower tolerances. The illustration in Fig. 1 shows a tube of Sintox ceramic forced by a 20 ton load through a ¼ in steel plate. The combination of properties which make this possible also form the basis for recent developments in machine tool operation using Sintox ceramic cutters. A technical advisory service is freely available at the company's Rugby address.

GRAPHITE LINED STEEL

A new form of tube which is metal-clad carbon or graphite has been given the name Metica, and is made by Talbot Stead Tube Company Limited of Green Lane, Walsall. An outer covering of ferrous or non-ferrous metal protects the carbon from damage and

permits higher working pressures. The makers expect that such tubes will be widely applied in chemical and oil refining processes where hot, corrosive acids and alkalies have to be piped.

A standard range is made in 6 ft lengths with bores from $\frac{3}{8}$ to 4 in, and special couplings, elbows and T's are supplied to secure continuity of the lining.

RIGID URETHANE FOAMS

The display by the Dyestuffs Division of ICI features rigid foams used in marine applications for insulation of ducting, ships' holds, deckheads and bulkheads. Both in these and in general heat and sound insulation, urethane foams show many advantages over such materials as cork and glass wool. They are extremely light (down to 2 to 3 lb per cu. ft), can be made virtually non-inflammable, demand relatively non-skilled labour and—best of all—can be foamed *in situ* to fill irregular cavities quickly and completely. Rigid foams bonded to plaster board or plywood, as illustrated in Fig. 2, can easily be cut to shape with normal wood-working tools.

Besides a demonstration of the special machines developed by ICI to mix and deliver the isocyanate and polyester or polyether components of these foams, the exhibits of this ICI division, whose head office is at Hexagon House, Blackley, Manchester 9, also highlights heat insulation by means of sprayed foams. Flexible urethane foams already find great use in the furniture and motor industries for upholstery and as carpet underlay, and in addition to application as heat and sound insulation, are being widely used as packaging materials.

UNORTHODOX SECTIONS

No explanation is offered for the demand for some of the odd copper sections shown in Fig. 3, but the fact is that Yorkshire Imperial

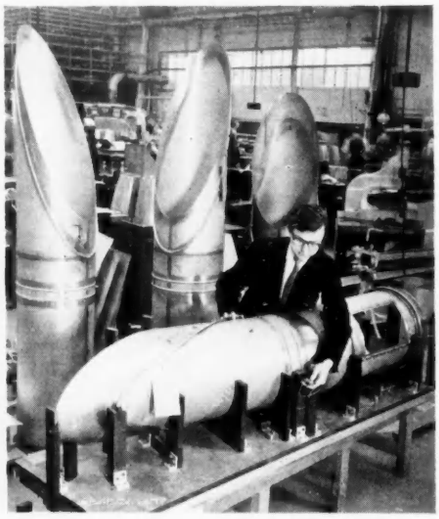


Fig. 5 The facilities which allowed fabrication of these argon-arc welded stainless steel jet pipes are now made available to industry.

Metals are being asked to provide them. Is it the bore or the metal clothing which is important? Perhaps both. Most are in fact for use in the electrical industries where there is now an increasing demand for internally cooled copper conductors. Particularly, they are applied in alternators where electrical output is limited by the use of solid windings.

The materials from which these conductors are manufactured are high-conductivity copper to BS1036 or 1037, silver-bearing high-conductivity copper, or the oxygen-free grade of high-conductivity copper to BS1861. The silver-bearing type, for example, is used for the

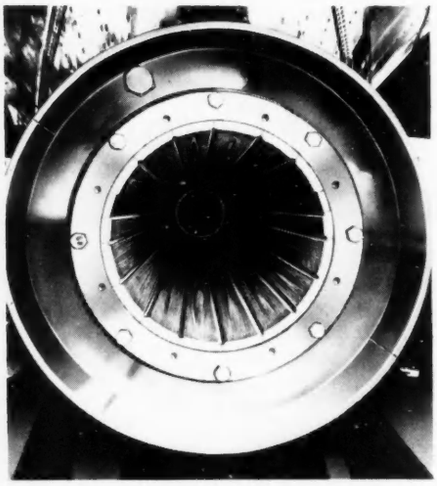


Fig. 4 A new brand of Tufnol is incorporated in this stern tube bearing for an ocean-going cargo vessel.

conductors of turbo-alternators as it possesses, in the cold worked condition, a higher softening temperature than normal high-conductivity copper, and has superior resistance to creep.

This company, whose address is PO Box 166, Leeds, are also exhibiting plastics tubes, and plastics covered small-bore copper tubes and fittings in their Kuterlex range. The coverings are $\frac{1}{16}$ in or $\frac{1}{32}$ in thick in polyethylene or pvc, and adhesive tape is supplied in the same materials for protection of junctions. Intended for instrumentation and steam tracer lines for use in corrosive atmospheres, the small-bore tubes are made with outside diameters of $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$ and $\frac{1}{2}$ in.

ABLE SEAMAN TUFNOL

About 12 months ago four new brands of Tufnol were introduced—Heron, Adder, Lynx, and Bear brands. The last of these has a fabric base with a medium weave and its most outstanding properties are good resistance to wear and low dimensional change. It is particularly suitable for bearings lubricated by water, and has been used extensively for rudder and stern tube bearings on ocean-going ships. Featured at the exhibition by the makers, Tufnol Limited, of Perry Barr, Birmingham 22B, and illustrated in Fig. 4, is a rudder bearing similar to that in service in the 40,000 tons deadweight Sven Salen, which is one of the largest motor tankers in the world. She has a 27 ton rudder carried in Bear brand.

Of the other brands, Heron is paper based and possesses the highest electrical insulation properties of all Tufnol. It is suitable for hot punchings. Adder brand is asbestos fabric based and may be used in some cases up to 200° C. With hard wearing properties, dimensional stability and good strength, this grade is produced as sheet, tubes and rods. Lynx brand is fabric based and, produced in sheets, is especially suitable for electrical insulation applications.

BRIGHT ANNEALING AND BRAZING

An essential requirement for the treatment of stainless and heat resisting alloys is a protective atmosphere, commonly of high purity hydrogen or a hydrogen-nitrogen mixture derived from ammonia. A new series of Birlec mesh-belt conveyor furnaces are provided with continuous, internal gas-tight muffles with sloping inlet and outlet tunnels, designed to prevent contamination and to reduce gas consumption. The heating chambers are fitted with silicon carbide elements which are easily removed and which enable working temperatures of up to 1,200° C to be attained.

The conveyor belt, which is 6 in wide in the example featured by Birlec, of Erdington, Birmingham 24, is in woven nickel-chromium wire mesh, and is driven by a system which ensures minimum tensile stress in the heated portion of the belt.

At the exhibition the furnace is equipped with a Birlec exothermic atmosphere generator of a recent and simplified design suitable for the smaller range of furnaces. The atmosphere provided by this equipment can be used for bright normalising and copper brazing of mild steel and the annealing of many non-ferrous metals. It is generated from ordinary town's gas or from liquid petroleum gas by combustion with air in closely controlled proportions.

SLAG WELDING

Rockweld Limited, Croydon, Surrey, have introduced a new automatic vertical slag welding machine, known as the Vertomatic. Manufactured according to patents held by Vus of Bratislavia, this equipment provides considerable economies in the welding of heavy plate of 2 in thickness and upwards. No plate preparation is required for this single-pass process and there are savings in weld metal, flux powder and electrical energy.

Typical of the time savings made possible was a vertical butt weld in two plates of $2\frac{3}{4}$ in thickness and 12 ft long. Welded with a small gap between the plate edges of $1\frac{1}{8}$ to $1\frac{1}{4}$ in, the time required was only 4 hours, compared with the equivalent time for manual preparation and hand welding with four operators, of one week.

With this equipment the molten weld metal and slag are retained in the gap by water-cooled copper shoes which ride on the faces of the plates and are traversed upwards as welding proceeds. Oscillation of the electrode wire in the gap is said to be important in securing satisfactory properties. Examination of typical welds has shown them to be radiographically perfect and to have good mechanical properties.

ELECTRODE PERSONALIA

As a result, say Murex Welding Processes, of the popularity of Fortrex 35 electrodes, a complete series has been introduced for the welding of mild and carbon steels in the 30 to 55 ton per sq. in range. Electrodes such as Fortrex 35 and 35A have been used extensively for hand welding in many nuclear power reactors in Great Britain. Fortrex 35A gives high impact values at sub-zero temperatures to welds in 3 to 4 in thickness plates.

The company (whose address is Waltham Cross, Herts) also show the new range of Suprex electrodes for various creep-resisting steels, and the Nicrex range for stainless steels. Electrodes in the latter range were used for all the metal-arc welding of the 40 ton stainless steel reactor vessels for the Dounreay fast-breeder reactor.

The password to electrodes for high speed deposition is apparently Ironex—a range of iron powder electrodes.

MATERIAL FABRICATION FACILITIES

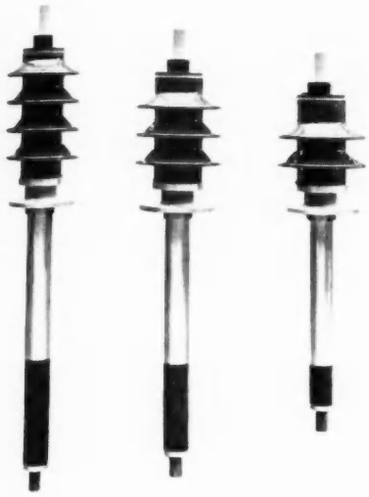
A large range of engineering facilities, on which the exhibition display is designed to focus attention, are now available to general industry from Sir W. G. Armstrong Whitworth (Aircraft) Limited, Baginton, near Coventry. Precision machinery is illustrated by a fuel can of the Calder Hall type with a continual-helix fin produced in one operation by the company. A Hufford A46 press allows stretch forming of heavy extrusions—there are only a few of these machines in this country—and large sheets can be similarly treated in a Hufford A56.

Argon-arc welding of light gauge stainless steel, which is a process still in its infancy, can be carried out, and is typified in a jet-pipe made for the Argosy which is shown in Fig. 5.

Much development work on fibre-glass moulding has been done at the Baginton factory, and the company are in a position to inject and pressure mould in many plastics including nylon, polyethylene and ptfe. In this latter connection the firm have developed a method of making moulds suitable for small quantity production very cheaply and quickly.

BUSHINGS FOR THE NORTH AMERICAN MARKET

A new range of Dialam apparatus bushings for electrical apparatus have been introduced by Permali Limited, Bristol Road, Gloucester, to meet North American (NEMA/CEMA) specifications. They are designed as a standard interchangeable oil circuit breaker and transformer bushing and are supplied for all standard ratings from 8·66 to 69 kV, 1,200 amps. The supply of replacement bushings for the North American Market has long been a problem, and the adoption of an interchangeable unit will now greatly simplify the spares problem for manufacturers and utilities alike.



In construction, these bushings are of a generally simple and robust design. There is no conservator head, and a spring washer assembly reduces the short air length. The insulating core is manufactured from a grade of Bakelised paper, giving high thermal stability and low dielectric loss characteristics plus good mechanical strength and resistance to moisture. Thin metallic foils are inserted during the wrapping process to provide conducting layers for controlling both axial and radial stresses.

REINFORCED PLASTICS PANELS

A new type of commercial van body, made entirely from reinforced Bakelite polyester resin, has been designed and is being built by Samlesbury Engineering Limited, of Samlesbury, near Blackburn, Lancashire. The prefabricated panels are also suitable for the general manufacture of containers, and of prefabricated buildings such as sheds and garages.

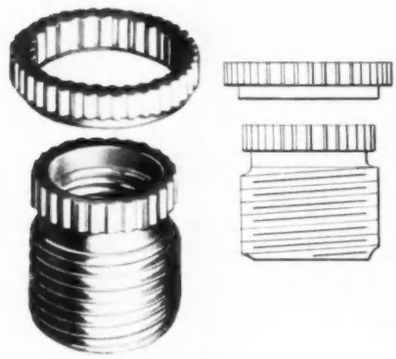
The Samlesbury van body, which requires no metal supporting framework, is constructed from two basic types of prefabricated reinforced resin panels—one for the sides and one for the roofing. Each panel is flanged on all four sides and they are assembled by securing the flanges of adjacent panels with small nuts and bolts. Moulded-in reinforcing ribs, also made from Bakelite polyester resin, give the panels adequate rigidity and the entire structure is secured to the floor and bearers by light-alloy angles.

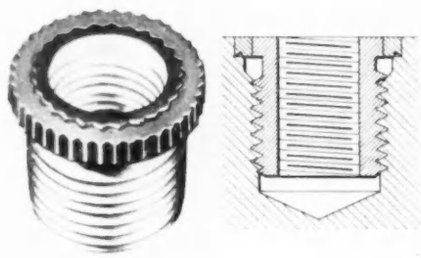
Among the features of the design are the excellent weight/strength ratio of the bodywork and the comparative ease with which the operator can carry out minor repairs with resin and glass-fibre materials. If damage is more extensive, a complete prefabricated panel can be unbolted and replaced in approximately 30 minutes. The rear doors, also of reinforced resin, are interchangeable and hung on conventional mild steel hinges. Impregnated colour panels can be supplied where required instead of the natural colour finish.

DURABLE TAPPINGS IN LIGHTWEIGHT CASTINGS

The increasing use of castings in lightweight metals, which have poor strength and wearing qualities compared with steel or cast iron, has presented a problem to the designer. Practically every component attached to such a casting is fixed by a tapped hole or a stud. Tapped holes in such metals tend to wear with use and to strip, and ordinary steel studs work loose.

An answer to this problem is now available with Rosan permanently locked studs and inserts, now manufactured in the United Kingdom by the Instrument Screw Company Limited, Northolt Road, South Harrow, Middlesex. They are similar to conventional threaded studs and inserts except for the addition of a serrated collar. The Rosan stud or insert is screwed into a prepared hole in the parent metal which has a counter-sunk neck. The associated lock ring is then placed over the stud or insert so that the inner serrations of the ring engage with the serrated collar of the stud or insert. The ring is driven into the parent metal, its body being accommodated in the counter-sunk recess at the top of the hole; its outer teeth, which are undercut to form broaches, cut their way into the parent metal, until the ring is flush with the surface of the metal.





Once secured, the stud or insert becomes part of the parent body, permanently locked in. Should it become damaged it is simple to remove and may be replaced with an identical unit. It can be replaced with a larger unit or a solid unit in the event of design change, wrong positioning or faulty processing, thus saving the scrapping of an otherwise correct and costly component.

No special drills, taps or gauges are required for the preparation of the holes for receiving the inserts and studs, standard National fine or coarse tapping only being required. The inserts and studs themselves are manufactured with a very slightly oversize effective diameter externally, thus ensuring a snug fit. Simple installation wrenches and punches are available, although not essential for fitting the pieces.

The system will be found to show to the best advantage where positive locking conditions are required under conditions of vibration, high stress and temperature changes or where frequent assembly and dismantling is necessary.

COOLING A STEEL MILL CONTROL CABIN

The problem of excessive temperature in the control cabin for a narrow strip mill at Stewarts and Lloyds Limited, Corby, has been largely overcome by the installation of unit air conditioners.

The control cabin, which is of sheet steel construction with numerous single-glazed windows, is situated only a few yards from the strip mill and backs on to a storage bay where hot bars are liable to be laid in close proximity to the rear wall of the cabin. In addition about 4 kW of heat are released from the electric control gear in the cabin.

Under the above conditions the temperature inside the cabin frequently approached 95° F. Several methods for reducing this temperature and improving the ventilation were tried without much success was not possible.

Eventually, in co-operation with Westool Limited, St. Helen's Auckland, Co. Durham, it was decided to install in the cabin two Westair 1 ton Duplex Climatisers and a Westair ½ ton Tropical Climatiser. In addition, approximately 250 cu. ft per min of fresh air was introduced into the cabin from above the mill roof.

Also, in order to reduce external heat input, a false wall of corrugated sheeting was erected about 12 in from the rear wall of the cabin on the bar storage side, with provision for allowing a free current of air. In addition, a 6 in high curb was built around the flat roof to provide an insulating layer of still air.

These measures have proved very successful in improving the atmospheric conditions inside this control cabin and the temperature has been reduced to below 80° F. In addition, since the windows and doors are now kept closed and only filtered air is circulated, the mill operators breathe clean air and the interior of the cabin is free from dust and grit.

The only criticism voiced by the three mill operators is that the atmosphere in the cabin is very dry, but this is easily rectified.

DESIGN AND EQUIPMENT OF DRAWING OFFICES

Part 2—Layout and Equipment

By F. J. LANGDON, B.A., D.PHIL., *Building Research Station, DSIR*

Concluded from page 507, 17 April

Drawing offices should be purpose designed. To find out what features make for a good drawing office, the Building Research Station have conducted a survey of ten existing offices in different areas of the country and representative of various branches of industry. The article is a short report of the principal findings. Lighting was dealt with in the previous issue. Space requirements, the layout of boards and reference tables, and equipment are discussed here.

Space and Layout

In the ten offices visited, total floor area, expressed as gross space per person, varied from 55 to 100 sq. ft. Where gross space fell below 60 sq. ft per person, considerable dissatisfaction was expressed; a reasonable figure that would satisfy the majority of draughtsmen would appear to be around 75 sq. ft per person. This figure assumes that standard equipment is used, but a slightly lower figure can be achieved by using special equipment.

Since the area occupied by the drawing board remains constant, independent of gross area, it follows that as the gross area is reduced to the minimum, the amount available for reference and circulation is very much curtailed. In the course of the study it became clear that it is this area, essential for study of reference material and consultation, which plays a decisive part in the smooth and efficient running of the office.

Assuming a reasonable provision of space per person, the key question is the overall way in which it is used, rather than the precise arrangement of furniture. Draughtsmen working in small offices holding ten to twenty people favoured the small office, and suggested subdivision of larger areas to achieve this. Draughtsmen working in large open offices, however, did not echo these views but seemed satisfied with the undivided space. Although it may be an advantage to consider subdivision of the area by shoulder-height partitions, there is little doubt that economic use of space, together with higher standards of lighting, ventilation and general comfort, favours a single area, as large as possible, accommodating all staff.

It is important to avoid free-standing pillars within the shell, so far as possible. Where curtain walling is employed, columns should be either incorporated within the shell, or placed outside it, rather than spaced-off within the glazing. If this cannot be avoided, great attention must be paid to the spacing of the columns. The spacing should, if possible, be a module based on the area occupied by one draughtsman, otherwise some draughtsmen will have columns obscuring their work positions, or, in avoiding this, floor space will be wasted.

The three conventional systems of layout, usually termed front, back, and right-angle reference, are illustrated in Fig. 5. Only front and back reference layouts were encountered in the course of the survey, right-angle reference being less generally used. None of the three systems was preferred overwhelmingly by the draughtsmen interviewed, the general opinion being that so long as reference space was adequate—and few ever agreed that it was—the detailed arrangement of furniture was of secondary importance so far as comfort and convenience of working was concerned.

Back reference would appear to be the most economical system of layout. It can be seen from Fig. 6 that front reference involves doubling the standing space, since with back reference the space for drawing is the same as that used for studying material. Furthermore, the fore and aft distance between drawing board and the back-reference table is less than that between two adjacent drawing boards in a front-reference layout. Using the space standards suggested by the survey findings, back reference would require an area 8 ft wide by 9 ft deep as against 13 ft by 6 ft for front reference, both widths being inclusive of one-half of a 6 ft gangway. This results in unit areas of 72 sq. ft and 78 sq. ft for the two layouts. Right-angle reference is not considered, since it cannot compare with either of these layouts for space economy, and is in any case suitable only for small offices as the transverse reference table limits free access to the board.

The two figures given above apply to individual draughtsmen. When they are combined in multiples within an actual office area, the exact amount of space per man will depend on the relative dimensions of the shell. Fig. 6 shows examples of planning modules applied in buildings of different widths and it will be seen that combinations 1 and 5 are normally more economical of floor area than 3, 4 and 7, though in certain cases where the building dimensions are unsuitable the reverse might hold.

On the standards proposed, namely, about 75 sq. ft per person, the most economical module is 16 ft for back reference, suiting buildings of 16, 32, 48 and 64 ft widths. The alternative is a module of 21 ft, giving economical widths of 21, 42 and 63 ft. Where the dimensions of an existing building do not permit any of these modules to be used, the front and back-reference layouts may be combined, as shown in examples 2, 4 and 6. The dimensions given above can of course be altered by making gangways narrower, boards and tables smaller, and reducing space between units, but the geometrical relationships will remain the same, so that the sample layouts can be used to calculate the number of places within a shell of known size.

In initiating the design of the building, the overall dimensions should be determined through multiplication of the basic modular units rather than by attempting to fit working positions into a predetermined shell. By dealing with this problem at the planning stage, the available site outline can be used to arrive at overall shell dimensions, using the layout modules shown in Fig. 6.

The space standards given above do not include that needed for storage, other than at the working position. So far as the survey findings are concerned, draughtsmen in most offices felt the need for more storage than was actually provided, and dissatisfaction was greatest among senior draughtsmen and section leaders who necessarily need more space both for storage and for reference than basic grades. In the older offices, material was usually stored in plan chests at the working position, supplemented by others under the charge of the section leader. For a modern office, plan chests are not the best method of filing prints. In most large organisations, master drawings are filed in fireproof rooms, prints being used for current reference. In this case, they can be folded and stored in conventional filing cabinets. Where drawings must be kept unfolded, they are best stored in vertical plan files from which they can be taken and replaced without suffering damage.

Unless special equipment is used, the rolling of drawings is not a satisfactory method of storage. Rolled drawings are not only difficult to lay flat, but when stored in cupboards or left about the office they are difficult to identify.

The bulk of prints which may be required for reference should be located in a single area, preferably within the office, certainly adjacent to it and on the same floor, rather than scattered among different sections. Material can then be controlled by a full-time clerk, and the common tendency to hoard drawings can be avoided. Moreover, where storage is centralised, it is easier to make allowance for expansion.

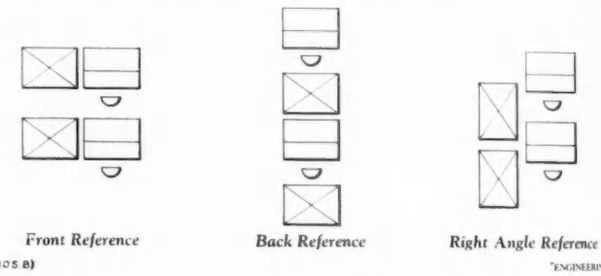


Fig. 5 Three arrangements of drawing board and reference table.

Apart from the storage area, there is a need for plenty of reference space. As already pointed out, draughtsmen felt that as much space as possible should be allocated for the study of drawings and documents. This means that at least one, and sometimes two, reference tables should be provided since these have to cater not only for laying out reference drawings, but also for writing notes, making calculations, and consultation with clients and designers.

Work studies carried out in seven of the offices surveyed showed that, on an average, only 30 per cent of all draughtsmen's time was spent in actual drawing, most time being given to studying reference material and obtaining information. Senior draughtsmen appeared to spend less than 20 per cent of their time on drawing, and the general result of the study confirmed the need to make ample provision for study, conferences, discussions and similar activities not carried out at the drawing board. If, therefore, it is not possible to provide senior draughtsmen with desks as well as drawing stands, it might in some circumstances be preferable to provide desks rather than drawing stands.

A point to be kept well in mind is the nature of the work load, for on this often depends the relation between drawing board, reference and

storage space. Thus an office carrying out continuous modifications may require more reference space and less long-term storage than, say, a development office. When an additional drawing office, or one replacing an existing office, is being planned it may be possible to obtain this information by means of a simple method study. Where a large amount of reference space is required, it may be profitable to erect continuous benching along the outside wall, as shown in Fig. 7, if this can be made consistent with the shell dimensions and without loss of daylight at the drawing boards. As can be seen from the illustration, such a possibility is a further advantage of top lighting, since the board may be moved from the window without loss of daylighting.

Finally, there is the question of communications. Although good daylighting is important, it is only one of many considerations in siting the office and its requirements must not be allowed to override all other factors. The drawing office is only one link in a chain leading to the finished product, and to fulfil its task effectively it must be in easy communication with other departments while, within the office itself, the layout must provide easy access to all working positions from any part of the room.

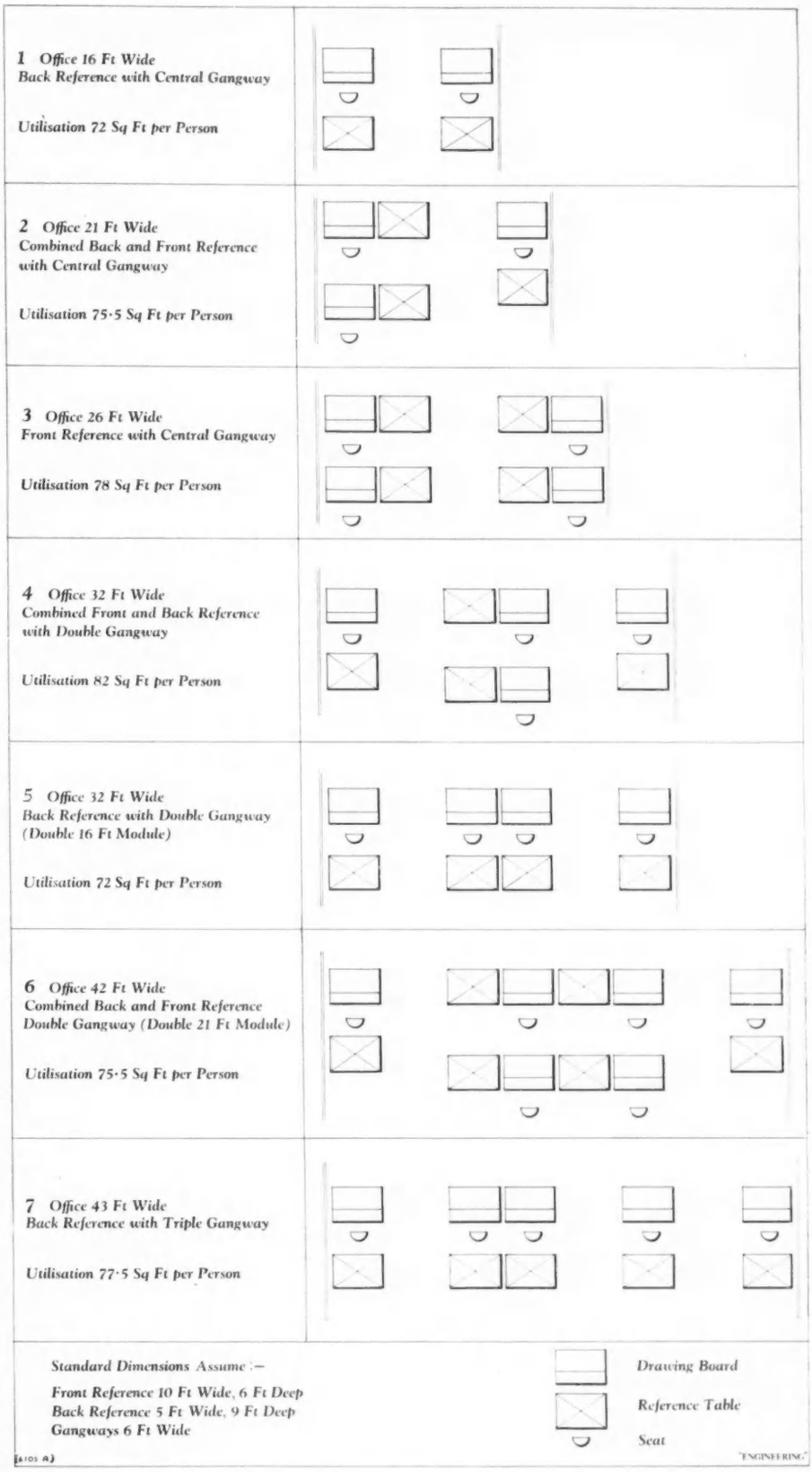

1 Office 16 Ft Wide
Back Reference with Central Gangway
Utilisation 72 Sq Ft per Person
2 Office 21 Ft Wide
Combined Back and Front Reference with Central Gangway
Utilisation 75·5 Sq Ft per Person
3 Office 26 Ft Wide
Front Reference with Central Gangway
Utilisation 78 Sq Ft per Person
4 Office 32 Ft Wide
Combined Front and Back Reference with Double Gangway
Utilisation 82 Sq Ft per Person
5 Office 32 Ft Wide
Back Reference with Double Gangway (Double 16 Ft Module)
Utilisation 72 Sq Ft per Person
6 Office 42 Ft Wide
Combined Back and Front Reference Double Gangway (Double 21 Ft Module)
Utilisation 75·5 Sq Ft per Person
7 Office 43 Ft Wide
Back Reference with Triple Gangway
Utilisation 77·5 Sq Ft per Person
Standard Dimensions Assume :—
Front Reference 10 Ft Wide, 6 Ft Deep
Back Reference 5 Ft Wide, 9 Ft Deep
Gangways 6 Ft Wide
Drawing Board
Reference Table
Seat
"ENGINEERING"

Fig. 6 Examples of layout modules.

An essential service, which the survey showed often to be neglected, is an efficient messenger system to convey drawings, memos, and other information between departments. Although messengers are essential for this purpose, the transfer of documents should be as direct as possible. For example, in one office visited, storage and records were placed on a lower floor to increase the useful top floor space in the interests of good daylighting. In consequence, each print required had to be brought from below by intermediaries and hoisted by goods lift to the drawing office, resulting in many errors and delays.

A further aspect of communications is the need for sufficient numbers of telephone outlets and external lines. In few of the offices visited were these adequate, and the delays and misunderstandings which resulted obviously offset any economies that might have been made in the initial installation.

Equipment

The survey showed that the drawing board and T square are no longer regarded as adequate by the great majority of draughtsmen. In the offices visited, more than half the draughtsmen used an adjustable draughting table and machine (either a parallel rule or a pantograph head) and 90 per cent of them preferred this to the older method. Of those still using a drawing board and T square, less than 40 per cent preferred to continue doing so, the majority wishing for a draughting table and machine.

There can be little doubt that the newer type of equipment is not only more popular, but is also more efficient and less fatiguing. At the same time, the design of draughting tables often came in for criticism, mainly because although easy to adjust for tilt, many types were difficult to adjust for height. Here, the answer seems simply that it is cheap and easy to provide for tilt adjustment though it is the height which requires to be most frequently adjusted. Some types of adjustable table carry large counterpoises and allowance must be made for the space they occupy, or great inconvenience will be caused to the man working in the position ahead. The same point applied to draughting machine heads. These may not only cause injury by striking the head of the next worker, but can collide with low hanging lighting fittings.

Where bench mounted adjustable boards are combined with reference tables, they should be fully counterpoised and easily adjusted. If this is not so, the advantage of an adjustable board will be lost, since the board will not be adjusted as often as it needs to be, and fatigue will be increased through work being performed standing that could have been done sitting down.

In a number of offices visited work surfaces were 36 in high, even where free-standing adjustable tables were employed. There appears little good reason for this, since a high stool with rungs for the feet is then necessary, which is neither a comfortable nor an efficient arrangement.

Reference tables should be 28 to 30 in high, used in conjunction with a normal height chair, preferably adjustable and swivelling. The draughtsman's feet will then rest on the floor, which is the proper place for them, so that they can be

moved freely in helping to maintain a comfortable and relaxed posture. Fig. 8 shows such an arrangement employing a fully adjustable board, and it will be seen that the operations involved in drawing can be performed without recourse to high stools and benches. If high surfaces are needed for discussions in a standing position, they can be located in other parts of the office, accessible from all sides. Plan chests, where used, are better suited to this purpose, and if placed well away from drawing boards have the advantage of taking otherwise distracting talk away from the drawing positions.

Fig. 7 (left) Continuous benching around office perimeter.

Fig. 8 (right) Draughtsman seated at adjustable bench-mounted board with work surface 30 in high and seated on standard chair.

Plan chests are often employed as reference tables, though they are not very suitable for this purpose, since they provide no free space for the legs of a seated person. The best reference surface is provided by a desk, 5 ft by 3 ft, with a long plan drawer and a single pedestal for storing instruments, books and files. Such a desk, designed for drawing office use, is now available and the storage space lost by replacement of the plan chest can be made good by the storage methods mentioned above.

Comfort

There are a number of points which were not included in the formal aims of the survey, but which were noted when studying the offices. First among these is ventilation. It is perhaps surprising that in the offices visited, ventilation was generally poor in old and new buildings alike. In almost all, the chief method of ventilation was by opening windows. This is of course quite unsatisfactory, since open windows produce annoying draughts, admit rain and dirt which spoil drawings, and allow papers to be blown about the office. As may be imagined, complaints on this score were very widespread.

Many of the offices visited had, by mid-afternoon, acquired an almost soporific atmosphere, since the opening of windows—the only means of ventilation—usually led to complaints and counter-action. Casement hoppers may sometimes be adequate, though often the only solution is either a plenum system or extracting ventilators. Where top lighting is used it maybe possible to introduce vent fanlights, though care must be taken to avoid water dripping on to drawings (this can sometimes occur with vents closed, as a result of condensation). Though it is seldom necessary to resort to full air-conditioning, the problem of ventilation demands much thought, since failure in this particular can nullify all the care taken over lighting and equipment, resulting in an office pleasant to look over but unpleasant to work in.

Noise is a frequent source of irritation in drawing offices, mainly because the general noise level is low, so that footfalls, discussion and telephone conversation intrude on concentration. For this reason floors should not be hard but should be surfaced with cork or rubber, while at least some of the telephones should be away from drawing boards or have acoustic desk booths. In certain cases, for instance, where sound is reflected internally by the walls of a long narrow office, ceilings may be treated with acoustic material. Noisy plant, such as printing machinery, should be located separately from the office, which should itself be sited well away from noisy industrial shops.

Cleaning constitutes an important part of current overhead costs, and therefore the design and equipment of the building must aim to make it easily and speedily carried out. Walls and ceilings should be decorated with materials easily cleaned, though the survey showed that gloss surfaces are not suitable since they often led to annoying glare and specular reflections from lighting fittings. Furniture should be either flush fitting or of such a design that the floor beneath is easily reached, and narrow gaps between furniture and side walls should be avoided.

Adequate cloakroom and lavatory accommodation must be provided, adjacent to the office and on the same floor. It was found that where separate cloakroom facilities with security lockers and means for drying wet clothes were provided, these were greatly appreciated.

It is important to remember that the provision of adequate amenities and a well-cleaned office influence, to some degree, the attitude of the occupants. Where these facilities are perceptibly substandard, they may well be regarded as an indication of management's lack of concern for the wellbeing of their staff.

In conclusion, two general points emerged clearly from the survey. In the first place, it was evident that drawing offices should be purpose designed. Adapted buildings rarely seemed satisfactory, being inefficient in the use of space and unattractive to the occupants. Second, it became clear that where top lighting was possible, its advantages were not confined to better daylighting, but had the effect of lessening design difficulties in general. Not only could the office be made of an economic depth, but its orientation and layout could be more freely handled to suit the circumstances of the site and the exigencies of other buildings and services.

All the points of criticism and design lines advanced in this article are based on information gained at one or another office in the survey, and cover the main directions in which it seemed that drawing offices could be made more efficient and comfortable. It should be appreciated that the study did not include any direct measure of efficiency. The criterion employed was solely that of satisfaction, expressed or inferred, on the part of the users.

The suggestions made here give only the barest outline of the needs for drawing office design. Many of its problems require the assistance of engineers, architects and experts on the design of equipment. It is hoped, however, that such guidance as is put forward here will help managements to make an intelligent appreciation of their own problems, and play a useful part in solving them.

Acknowledgment.—The work covered in this article forms part of the research programme of the Building Research Board and is published by permission of the director of Building Research. Thanks are due to Mr. J. B. Collins, who was responsible for the physical aspects of the lighting studies.

COMPETITION FOR ALUMINIUM LIGHTING STANDARDS

The Aluminium Development Association is sponsoring an open competition for the design of aluminium street lighting columns. The object of this competition is to encourage the evolution of good designs (taking especially into account aesthetic appearance, economy of construction, and the advantages of aluminium) and the eventual wider adoption of such lighting columns in Great Britain.

The assessors, who will be assisted by a panel of technical advisers, are the Hon. Lionel Brett, representing the Royal Institute of British Architects, Professor Sir Alfred Pugsley, past-president of the Institution of Structural Engineers, and Sir Gordon Russell, director of the Council of Industrial Design.

Entries are invited from lighting specialists, architects, industrial designers, engineers and other individuals or groups. Competitors may submit more than one entry, and joint and group entries are allowed.

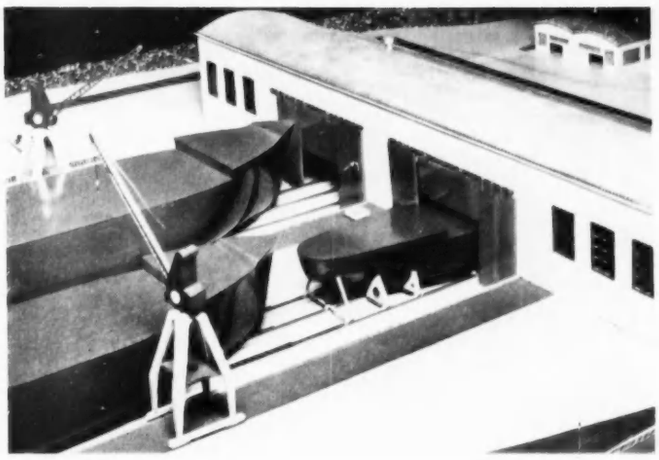
Copies of the competition regulations and conditions (with specification and design requirements) and of the entry form may be obtained from the Secretary, The Aluminium Development Association, 33 Grosvenor Street, London, W1. The closing date for the receipt of entries is 1 July.

PRODUCTION LINE FOR SHIPS

A RADICAL departure from traditional methods is being made in the new shipyard which Aktiebolaget Götaverken have started to build at Arendal, near Gothenburg, Sweden. Ships up to about 40,000 tons deadweight can be built at the existing Götaverken shipyard at Gothenburg, but because harbour installations surround the yard it cannot be increased in size. At the same time, the river is not wide enough to allow ships of greater size than the present limit to be launched. Götaverken therefore decided to build a new yard and to take advantage while doing so of the possibilities inherent in line production to reduce building costs and to speed up production.

This modern yard, which will cost the equivalent of about £10,250,000, is being built on a site of about 1,200,000 sq. yds, which is nearly four times the size of the present yard. About a third of the available area will be brought into use at first, the remainder being kept for future development. Completion of the project, which has been planned by Mr. Nils Svensson, a director of Götaverken, is scheduled for the end of 1962.

An artist's impression of the new shipyard being built by A.B. Götaverken illustrates the layout for line production of ships, which are finally floated from a dry dock.



A model of the assembly shop shows how ships pass into the dry dock as they are built up from prefabricated sections.

MOVEMENT ON CONVEYORS

Narrow in proportion to its length of about 1,100 yd, the shipyard is laid out for straight line movement of materials and sub-assemblies from the fully mechanised steel stockyard to the point where the final assembly is carried out and the ships enter the water. Ships built in the yard will be almost entirely of welded construction, and practically all the welding will be carried out under cover. Materials from the stockyard will pass, by conveyor, through the preparation and pre-fabricating shops to a large welding shop lying across practically the entire width of the yard. Here the sub-assemblies will go to one of two parallel building lines, which extend out of the shop and run the length of two large dry docks, each capable of taking a vessel up to 100,000 tons d.w., or alternatively, two smaller vessels side by side.

As the sections are completed and the ship begins to grow, the stern will be moved out of the shop into the dry dock on steel roller conveyors of entirely new design, for which Götaverken have patents pending. Sections of up to 200 tons each will thus be welded together to form a complete ship, the joining operation being carried out under cover. The principle to be adopted is clear from the model shown above.

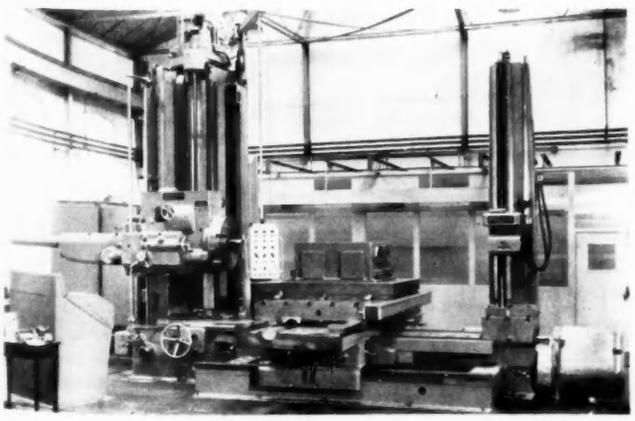
Because the work of welding will be unaffected by weather conditions, production can be planned accurately, and it will be possible to make much greater use of automatic welding machines, so reducing costs. To a considerable extent the workers in various trades will be given fixed working places, the principle being, as in other line-production installations, to bring the work to them and their machines.

LAUNCHING BY FLOODING

When a certain amount of hull construction has been completed, the installation of machinery and internal fitting-out will be started. This work will proceed while the rest of the hull is being built, and will be planned to finish at the same time, that is, when the bow of the ship leaves the assembly shop. All that will then be necessary will be to flood the dry dock, tow the ship out, and pump the dock dry again ready to receive the next hull, the stern of which has already started to take shape in the assembly shop.

The planned output of the yard is about 180,000 to 300,000 tons d.w. per year, depending on the size of the individual ships. An example of the speed at which work will proceed is provided by the fact that the total building time of a 40,000 ton tanker is calculated to be about 20 weeks. While the layout of the yard is ideal for such ships as large tankers, which are being built as a standard series, it is equally applicable to ships of other types. As already mentioned, if the ships are smaller, (up to about 20,000 tons d.w.), two of them can be built side by side simultaneously in each dock.

When the new yard is completed the three smaller berths at the existing Götaverken yard will be dismantled, leaving only the two biggest and most modern ones in operation; these will be used for " single " ships and vessels of special types. The floating docks, ship repairing facilities and engine works at Gothenburg will continue in use as before.



A well-known principle, electronic control of co-ordinate setting, is here applied to a large Kearns horizontal boring machine.

TOOLROOM ACCURACY ON SHORT-RUN PRODUCTION

Many machines of different types have been built with electronic control of the traverses for fully-automatic quantity production, and a considerable amount of information on the subject has been published. There is, however, a further application of this type of control which has not been so widely publicised—the control of machines which are primarily suitable for the manufacture of single items, or for very short production runs. Since jigs and fixtures, the preparation of prototypes and other tool room work fall in the " one-off " and short-run categories, accuracy is an obvious requirement in the machine and in the equipment used for controlling it.

Considerable attention has been given to the question of developing horizontal boring machines with automatic positioning by electronic means, and machines so constructed have been in successful use for a number of years. Developments in electronic controls have been

rapid, and a large machine has now been built to take full advantage of the accuracy obtainable from this type of control.

Built by H. W. Kearns and Company Limited, Broadheath, near Manchester, the machine is a universal horizontal boring, surfacing, drilling, tapping and screwcutting machine designed for single or batch production of components up to about 5 tons in weight. It is to be installed at the Rugby works of the British Thomson-Houston Company Limited, and is equipped with that company's two-dimensional electronic co-ordinate setting system with depth control. With a 4 in diameter spindle and a compound table 4 ft by 9 ft, the machine is claimed to be the largest horizontal boring machine in the world with electronic control.

CO-ORDINATE SETTING

Mechanically the machine is equipped with some unusual features, including a 5 ft square multi-jack revolving table, which can be rotated very easily even when carrying an offset load. Automatic hydraulic clamping is fitted to the vertical adjustment of the spindle slide, boring stay bearing, and longitudinal and transverse movements of the main table. In addition to a screwcutting attachment for the longitudinal table movement, there are full ranges of mechanical feeds both in in/min and in in/rev of the spindle for the radial movement of the facing slide and the axial movement of the travelling spindle.

The BTH co-ordinate setting operates, through servo mechanisms, the vertical traverse of the spindle slide and the transverse and longitudinal traverses of the compound table. Six dials are provided on the control desk adjacent to the machine for each of the three positional settings, enabling the vertical, transverse or longitudinal displacements to be set in units of 10, 1, 0·1, 0·01, 0·001 and 0·0001 in from any predetermined datum point. Setting of the dials can be individual, by hand, or in groups by means of standard punched cards, a pack of which can be inserted in the automatic card reading unit. After individual automatic reading, the cards are ejected into a collecting hopper. An inspection window enables the operator to read the top card in the collecting hopper if necessary. Control of the card reading unit can be either from the desk or from the pendant push-button control adjacent to the machine column.

All three servo systems controlling the traverses are identical. A heavy section cast iron bar carrying the inch units—identical blocks with $\frac{3}{4}$ in diameter holes having a non-magnetic insert—is the basis of the electrical measuring system, and an electromagnetic sensing head works in conjunction with the measuring bar to provide the electrical control signals. During the approach to final alignment under the control of the electromagnetic head a temporary signal is automatically injected, so that approach is always made from the same direction.

SUSTAINED ACCURACY

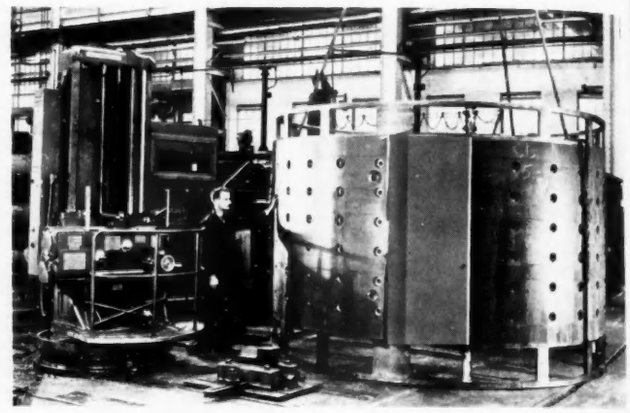
Full manual control of the machine is provided from the pendant, which also incorporates means for controlling the card reading unit, and has a push-button stop for all motions.

Experience with machines using similar control equipment has shown that not only is the reaction of the operator favourable, but that the saving in machining time can be considerable. A customer's operator sent to the works of the machine manufacturer for training reduced his floor-to-floor time from 535 to 319 minutes, as compared with the method then used in his own shop, on only the third component machined. The operator reported that since he was always sure of his centres he could devote the whole of his time to the maintenance of bore accuracy, and as part of the responsibility for accurate setting had been taken over by the machine, he found his day's work much less fatiguing. The importance of lessening operator fatigue in the interests of maintaining consistent accuracy is obvious.

TAKING THE MACHINE TO THE JOB

It is often an advantage, when a component is large, or of awkward shape, to take the machine to it, rather than to move the component to the machine in the usual way. Valuable space can be saved by using a transportable machine tool, which is very small compared with a stationary machine capable of doing the same job; and it is usually easier to handle the machine, which is designed to be picked up by a crane, instead of a large workpiece such as a heavy fabrication.

An example of the application of this principle is provided by a recent installation at the Rugby works of the Heavy Plant Division of Associated Electrical Industries Limited. Among the items to be machined are fabricated magnet frames for large d.c. motors and generators, which range in size up to about 15 ft internal diameter and 7 ft long. After being bored and faced, the frames are drilled radially for the bolts which secure the pole pieces.



The Swiss "Rigid" transportable drilling, boring and milling machine is designed to work inside cylindrical workpieces, such as the fabrication seen alongside it.

For this purpose AEI have installed a Swiss "Rigid" transportable drilling, boring and milling machine. This machine, which was supplied through the British agents, Dowding and Doll Limited, 346 Kensington High Street, London, W14, is specially designed for working inside cylindrical workpieces with internal diameters from 4 ft 11 in to 16 ft 5 in.

The base of the machine has a circular table and the column can be rotated through 360° by hand feed or quick power traverse. Micrometer adjustment is provided for setting the angular position of the column, which can then be clamped. The spindle can be moved vertically through a distance of 4 ft 11 in by hand or power traverse. A noteworthy feature is the longitudinal displacement of the complete spindle carrier up to 27½ in.

There are 32 spindle speeds, from 9·5 to 1,356 r.p.m. and 20 boring and fast feeds from 0·12 to 7·85 in/min. Vertical and horizontal milling are catered for by a range of 20 feeds from 0·35 to 23·6 in/min. All the controls are within easy reach of the operator, who stands on a platform which is raised, lowered and rotated with the spindle carrier.

Either of two methods of working can be adopted, to suit the shop arrangements at the particular time. The machine can be left in place and a frame lowered round it, or, when the floor space is fully occupied by fabrications, the machine can be lifted from one job to the next. As soon as the machine is removed from the frame, assembly work on the component can be commenced without the need for further lifting and movement.

REDEPLOYING LARGE ORGANISATIONS

The problems of change in large-scale organisations was the subject of a paper presented to the Royal Society of Arts by Mr. Christopher T. Brunner, a director of Shell Mex and BP Limited. The chairman of the meeting, Sir Arnold Plant, professor of commerce, University of London, introduced Mr. Brunner as "responsible for the distribution of more oil in this country than any rival director of marketing." Mr. Brunner's paper "Large Scale Organisation and Change: a Study in Oil Marketing" was mainly based on his own company's experience and more particularly on the very extensive recent changes in their internal structure.

The paper gave a fascinating picture of a major exercise in distribution. Complexity was caused initially by sheer size and the extent of the functions played by the company. Too much was attempted, in what amounted practically to retail distribution, deliveries in small drops to individual filling stations, and too much was controlled from the top. The reorganisation which Mr. Brunner described has entailed the recognition of certain underlying concepts: the principles of decentralisation, specialisation and simplification have been applied wherever possible. "Bigger and better" has been at the root of the planning for depots, tanks and vehicles, and the nature of the operations performed by the company was more closely related to the company's own inherent characteristics and size.

In Mr. Brunner's own words, "the principle of never doing yourself something which others can do better and cheaper has been reflected in the policy of contracting out." Many large companies could benefit from the application of this concept, and from the simplification of administrative routines which took place at Shell Mex and BP.

MACHINE TOOL TRADER

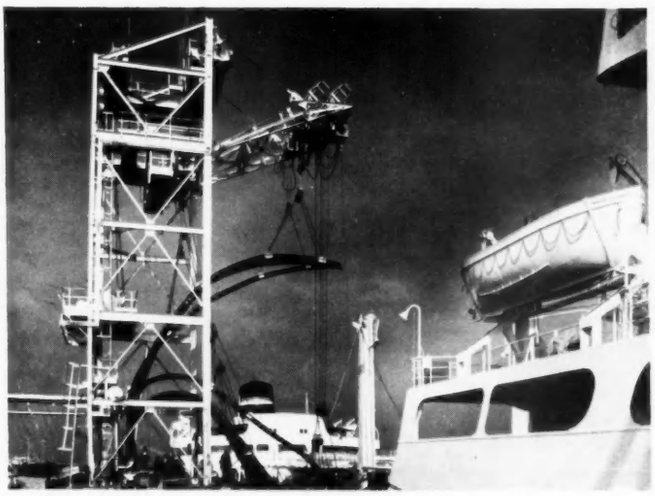
A new vice-president, Mr. J. C. Snow, was elected by the Machine Tool Trades Association at their recent annual meeting. Mr. Snow is a Sheffield man, born and educated, and was apprenticed there to his family business, Snow and Company Limited. He is now joint managing director of the company, who are manufacturers of surface grinding machines and special-purpose machine tools incorporating automation principles. Mr. Snow was elected to the Council of the MTTA in 1953 and to the manufacturers' section committee in 1955.

Operation and Maintenance

PNEUMATIC EQUIPMENT SPEEDS TANKER TURN-ROUND

To meet the need for quicker turn-round of oil tankers, coupled with the increase in the size of the vessels themselves, bigger pipe lines and ship-to-shore hose connections have to be used. These hoses, which are becoming increasingly heavy and cumbersome, have to be handled carefully and precisely, and at the same time as quickly as possible.

Extensions to the Fawley refinery of the Esso Petroleum Company Limited, carried out by Foster Wheeler Limited in conjunction with Woodfield Rochester Limited, to Esso specifications, include hose-handling equipment operated by compressed air. This medium not only gives flexibility of working, but has obvious advantages in a situation where inflammable liquids are being handled.



Holman air hoists and Maxam controls combine to provide safe, rapid and flexible handling of ship-to-shore hoses at Fawley refinery.

The largest of the new Fawley installations is designed to deal quickly with ocean-going tankers. Large flexible hoses used for ship-to-shore connection are supported from a pivoted boom, and controlled by air hoists. Positioning of the hoses for coupling to the tanker manifolds and compensation for ship movement due to tides, drifting or change of draught, are carried out by luffing the boom and adjusting the pay-out of the individual hoists.

Nine reversible pneumatic hoists, made by Holman Brothers Limited, Camborne, Cornwall, are used, their control being centralised on a panel located on the jetty. The control valves are Maxam neutral position lever type, supplied by the Climax Rock Drill and Engineering Works Limited, a member of the Holman organisation. Control of a 13-ton boom luffing winch is also effected from the Maxam panel.

There are five pendant trolley hoists on the boom, all of them being arranged to traverse parallel with the ship's hull. Four non-traversable hoists mounted on the main structure pair with four of the five on the boom to support combinations of hoses which are linked by bridles. The fifth of the boom-mounted hoists traverses the whole width of the boom at the outer end, and is moved to each hose or combination of hoses as required to assist in the final positioning with the tanker manifold.

Four smaller hose-handling units have also been installed at Fawley to deal with coastal tankers. Holman hoists and Maxam controls are also used on these installations, which are similar in principle to that used for ocean-going vessels.

ELECTRICITY IN NORTH SCOTLAND

The demand for electricity in the North of Scotland continues to rise and the number of units sold during last year was more than three times what it was in 1948. Power stations generated 2,143 million units of electricity, 1,683 million of which were produced by water power. This was an increase of 130 million on the total generated in 1957.

These figures are included in the annual report (see Weekly Survey 13 March) of the North of Scotland Hydro-Electric Board, who state that in their first 15 years they have completed the development of about a quarter of the estimated usable water power resources of the Highlands and carried the benefits of electricity to more than 90 out of every 100 people in their area. This was achieved without any Government grants of any kind and at the end of the 15 year period the deficiency on revenue account stood at £724,456 after a loss of £112,238 on operations in 1958. This was due to rainfall in the catchment area being 14 per cent below average, necessitating a considerable increase in expenditure on steam generation and on the purchase of electricity from the south. The board underline the fact that this is the second year in four that the annual rainfall has been well below average, and that there has been " a considerable shortage of rain " over these last four years.

The Highland grid system now totals 1,630 circuit miles with another 250 circuit miles being built. The board's main transmission system has so far been limited to 132,000 volts but during the year they have decided to have a number of 275,000 volt lines to meet future requirements. The average number of contractors' workmen employed on the construction of hydro-electric schemes and on the erection of lines and installation of equipment over the year was 4,900. The board's own employees at the end of the year numbered 2,861. The total capital expenditure during the year amounted to £15·4 million and the aggregate capital expenditure to the end of the year was £192,301,000.

TABLE.—*Expenditure of North of Scotland Hydroelectric Board*

Hydro-electric schemes	£132,591,000
Steam and diesel power stations	£5,522,000
Transmission lines	£15,135,000
Distribution	£37,545,000
Sundry	£1,508,000
	£192,301,000

Marketing

Radioactive Samples

A nuclear energy building in which nine nations are demonstrating their progress in atomic engineering is a feature of the International Samples Fair which opened in Milan, Italy, on Sunday, 12 April. The United Kingdom Atomic Energy Authority have booked 3,500 sq. ft and are one of the largest exhibitors in the section.

Special reference was made to the construction by British firms of the Italian atomic power station at Latina, as an illustration of the considerable experience gained by Britain in reactor design and construction. A display of isotopes showed how they can be used as measuring devices, as antibiotics and for other medical purposes, as sources of light and for radiology. The exhibits were supported by films, shown with simultaneous separate sound tracks in four languages. There is no doubt that our most modern industry is using to the full the most modern methods of sales promotion available—a comforting sign of the industry's fighting qualities.

Tempting the Teenager

A Teenagers' Fair, planned to attract young people, is to be held at Blackpool from 21 to 27 September. Its object will be to show teenagers, who spend £900 million a year, the latest available goods in their sphere of interest, including hobbies, sports equipment, gramophones as well as exhibits covering such items as adult education, careers, outdoor recreation, the Services, entertainment on stage and screen, television, and the social services.

The organisers, Anglo-European Exhibitions Limited, estimate that some half a million young people visit Blackpool for their annual holidays, and consider that the exhibition will be very well attended.

South Africa Reclaimed

Earlier this month delivery began of one of the largest export orders for main line locomotives ever placed in this country. A 2,200 h.p. electric locomotive was shipped from Liverpool to South Africa, the first of the 135 locomotives ordered by the South African Railways from Metropolitan-Vickers South Africa (Pty) Limited. The delivery rate is planned to reach five locomotives a month by the end of this year.

This marks the re-entry on a large scale of British locomotive manufacturers into a market which had largely been taken over by United States and German manufacturers. It is a welcome sign of recovery by an industry which had for many years been a leading exporter. The locomotives are built at the Stockton works of Metropolitan-Vickers-Beyer, Peacock Limited.

Aviation Earning Power

The exports of the British aircraft industry continue to grow, despite the considerable impact of American jets on world markets. In the first two months of this year they totalled £22·5 million, 6 per cent more than in January-February of last year and 47 per cent more than in the corresponding period of 1957. An example of the industry's energetic activities is Handley Page's promotion of the Herald branchliner, powered by Rolls-Royce Dart engines. One left recently on an extensive overseas tour.

The Viscount airliner continues to establish itself as the best steady worker of the air, taking over the position held for so long by the Douglas DC3. In operation it has proved to have the cheapest plane-mile direct costs (85·65 cents) of any modern aircraft, twin or four engines, operated by domestic carriers in the United States. Only out-of-date aircraft, the DC3 (61·18 cents) and the Lodestar (73·16 cents)

have lower plane-mile costs. The nine Vickers Viscount V 810's operated by Continental Airlines of Denver, earned a net income of $1·3 million in the months May to December, 1958.

This excellent earning power is the basis on which British aircraft last year sold abroad to the value of £148 million, an increase of one third over the previous year despite the fact that total British exports were lower. It is a tribute to an industry whose downfall has been predicted with monotonous regularity ever since defence expenditure was reduced.

Slot Machine Dividend

Great efforts are being made to awaken the business instinct in each one of us by the Master Vending Machine Company. The methods used are most direct: a letter to a sample of likely customers, presumably selected among the higher income groups; a visit by an area representative whose task is to sell hard and to assess the approximate standing of the prospect, and a visit by a more senior representative, probably the area manager, who opens negotiations.

The object is to find men with some spare time—" a few spare hours per week "—and some spare cash—" an initial cash investment of only £90 is all that is required "—who are willing to look after vending machines and to invest part of their earnings in the business. " As much as £20 clear profit " is held out as the main attraction, and " ambitious, business-like " are the qualities in demand. All the recipient of the circular has to do, when he has read the letter and the attached printed leaflet " The Master Profit Plan," is to fill in a pink form indicating he is willing to comply with the three basic conditions. The representative piles on the sales pressure and intimates that £90 is the minimum investment and that the company do schemes between £90 and £90,000. Significantly, perhaps, the general sales manager, Mr. R. W. Jerram, ends his letter with the words " This is a limited offer . . . please act now."

Family Face

An unusual exhibition was held in London, at the Ceylon Tea Centre in Regent Street, to show how firms express their personality through " house style." Organised by Mr. Alec Davis for the Design and Industries Association and designed by Mr. Ian Bradbery, MSIA, the exhibition displayed material from over 40 British firms as well as contributions from Europe, America, Asia and Australia.

The purpose of the exhibition was to show that a good house style is aesthetically pleasing to those who see it and commercially successful for the firms who sponsor it. It demonstrated that much is to be gained from the co-ordination of print, display and promotion material, packaging, letterheads, invoices, delivery vans, trade marks, premises and, where appropriate, the product. Each reflected the personality of the firm, thereby creating among employees, customers, suppliers and shareholders alike a feeling that whatever they saw was recognisably " the company."

Among the exhibits were some by leading engineering firms, such as British Olivetti, Ferodo, IBM, Spear and Jackson, Robert Watson and our own journal.

At Home

TAPE RECORDER AT LOW COST

The idea of using the drive motor and the amplifier of a gramophone or radiogram to operate a tape recorder deck sounds attractive, but impractical. However, it has now been shown to be quite practical, and Andrew Merryfield Limited, 29 Wrights Lane, Kensington, London, W8, are marketing a tape deck, known as the Gramdeck, which can be driven from any gramophone turntable and played back through the gramophone, or a separate radio, amplifier.

The advantages of this type of tape deck are quite significant. By using an existing motor and amplifier, two of the most expensive requirements of a tape recorder are eliminated, enabling the Gramdeck to be sold at £13 12*s* 0*d*, which is substantially less than any complete tape recorder yet marketed. Furthermore, the amplifier of a good quality radio or radiogram is often capable of higher quality reproduction than that of a portable tape recorder, if only by virtue of a larger loudspeaker. Thus this new tape deck enables the disc record enthusiast to have the best of both worlds. By using the Gramdeck, which can be mounted and dismounted on the turntable as easily as a record, he is able to use his gramophone to record on tape and to play either tape or disc record at will. The only significant disadvantage of this type of deck is that, unless it is used in conjunction with a portable gramophone/amplifier, it is not fully transportable.

To use the Gramdeck, two leads must be connected to the extension loudspeaker (ES) and the pick-up (PU) terminals which are to be found at the rear of most types of radio or radiogram. Recording or playing the tape is then simply a matter of placing the deck on the turntable, in the same way as putting on a record, and switching on.

By adjusting the turntable speed, the tape speed can be varied between 7·5 in per sec (78 r.p.m.) and 1·6 in per sec (16⅔ r.p.m.). At 7·5 in per second, a standard 5 in reel of tape will run for 30 minutes giving good quality recording, and reproduction which is said to be at least as good as that obtained from a micro-groove disc. At slower speeds the playing time can be increased up to 140 minutes, but the quality, as with all tape recorders, reduces with lower speeds until it is no longer suitable for music.

The control box, which is supplied with the tape deck, is a separate unit. As well as containing the necessary switch mechanism to control the deck, it contains a transistor pre-amplifier. When playing pre-recorded tape, the pre-amplifier raises the signal from the magnetic head to a level comparable to that of a gram pick-up, and at the same time it applies frequency response equalisation so that the overall response of the head and amplifier conforms to the internationally accepted CCIR replay characteristic.

NEW TELEPHONE CODES FOR LONDON

Dial " 0 " becomes " 100 "

Important changes in certain telephone dialling codes for London were introduced on 6 April as an early preliminary to Subscriber Trunk Dialling. " O," " TRU " and " TOL " have disappeared and have been replaced by " 100." This is to be used in all cases where a subscriber wishes to make an inland call which he cannot dial himself, or to seek assistance from the operator on any directly dialled call.

A second code " INF " has also been introduced for subscribers who seek general information about the telephone service or to call the supervisor. The present code " TKD," which has been used to obtain access to trunk directory enquiry has also been suspended and all directory enquiries, long distance as well as local, must now be obtained by dialling " DIR." Other codes such as ENGineers, CONtinental, INTernational, and TELegrams remain unchanged, as does the " 999 " service for emergencies.

The area covered by these changes is called the Director Area and it comprises all those exchanges having the first three letters printed in heavy capitals in the London directories.

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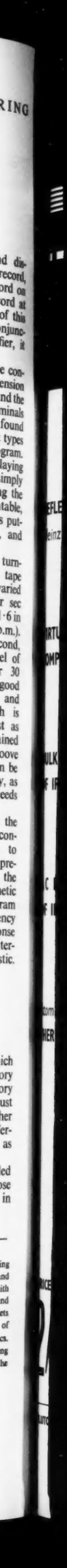
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